

## 4.7 NOISE AND VIBRATION

This section summarizes the noise and vibration impact analysis in support of the environmental review of the proposed Green Line. Technical details of this analysis are presented in Appendix R, Noise and Vibration Backup Information.

### 4.7.1 Affected Environment

#### 4.7.1.1 *Introduction to Noise Terminology and Descriptors*

The human ear responds to a wide range of sound intensities. The decibel (dB) scale used to describe sound is a logarithmic rating system that accounts for the large differences in audible sound intensities. Using this scale, humans perceive an increase of 10 dB as a doubling of loudness; for example, a 70 dB noise level sounds twice as loud as a 60 dB noise level. Under ideal listening conditions, people generally cannot detect differences of 1 dB, while differences of 2 or 3 dB can usually be detected by people with normal hearing. In the outside environment, and especially near complex noise sources such as roads, sound level changes of 2 or 3 dB might not be noticeable to most people, while a 5 dB change would likely be perceived as a clear and noticeable change.

Because of the logarithmic scale used to describe noise, a doubling of a noise source strength (e.g., twice as much traffic on a road) produces a 3 dB increase in average roadway noise. Such an increase would not be perceived as a doubling in noise loudness, which requires a 10 dB increase. Sound levels caused by line sources (e.g., relatively long, variable, or moving sound sources) such as traffic decrease at a rate of 3 to 4.5 dB when the distance from the road is doubled, depending on the type of surface between the source and the receiving property (e.g., hard or soft). Sounds from discrete events or stationary point sources, such as an idling bus, decrease by 6 dB when the distance from the source is doubled. Conversely, halving the distance to a source increases sound levels by 3 dB and 6 dB for roadway and point sources, respectively.

When addressing the effects of noise on people, one must consider the frequency response of the human ear, or those sounds that people hear best. To address the frequency response, instruments that measure sounds are designed to weight measured sound levels based on emphasizing the frequencies people hear best, and de-emphasizing those frequencies people do not hear as well. The frequency weighting most often used to evaluate environmental noise is A-weighting, and measurements from instruments using this system are reported in A-weighted decibels or dBA. All sound levels in this evaluation are reported in A-weighted decibels.

For a given noise source, factors affecting the sound transmission from the source and the potential related noise impact include distance from the source, frequency of the sound, absorbency of the ground surface, the presence or absence of obstructions and their absorbency or reflectivity, and the duration of the sound. The degree of impact on humans may also depend on existing sound levels. For example, if existing sound levels are high, introducing a new noise source tends to have less impact than in an environment where background noise levels are low. Typical sound levels of some familiar noise sources and activities are presented in Table 4.7-1.

Many regulatory agencies use the equivalent sound level ( $L_{eq}$ ) to evaluate noise impacts. The equivalent sound level is the level of a constant sound that has the same sound energy as the actual fluctuating sound. As such, the  $L_{eq}$  can be considered an energy-average sound level. But this noise metric should not be confused with a simple arithmetic average that may under-represent high and low values; an  $L_{eq}$  tends to emphasize louder sound levels because they contain more sound energy than lower levels. And the  $L_{eq}$

has been found to be highly correlated to community perceptions of noise and to the potential for annoyance from noisy activities. When referring to sound levels, it is important to identify the time period being considered, with  $L_{eq}(24)$ , for example, being the equivalent sound level for a 24-hour period. The day-night sound level ( $L_{dn}$ ) is similar to an  $L_{eq}(24)$ , except that the calculation involves adding 10 dBA to sound levels measured between 10:00 p.m. and 7:00 a.m. to account for potential sleep interference.

**Table 4.7-1. Sound Levels Produced by Common Noise Sources**

Thresholds/ Noise Sources	Sound Level (dBA)	Subjective Evaluations <sup>a</sup>	Possible Effects on Humans <sup>a</sup>
Human Threshold of Pain	140	Deafening	Continuous exposure to levels above 70 dBA can cause hearing loss in the majority of the population
Carrier jet takeoff at 50 feet			
Siren at 100 feet	130		
Loud rock band			
Jet takeoff at 200 feet	120		
Auto horn at 3 feet		Very Loud	
Chain saw	110		
Noisy snowmobile			
Lawn mower at 3 feet	100		
Noisy motorcycle at 50 feet			
Heavy truck <i>maximum</i> at 50 feet	90	Loud	Speech interference
City bus <i>maximum</i> at 50 feet			
Aerial Rail Transit @ 50 mph at 50 feet	80		
Busy urban street, daytime			
Idling Bus @ 50 feet	70		
Monorail @ 40 mph at 50 feet		Moderate	
Air conditioning unit at 20 feet	60		
Conversation at 3 feet			
Quiet residential area	50		
Light auto traffic at 100 feet			
Library	40	Faint	Sleep interference
Quiet home			
Soft whisper at 15 feet	30		
Slight rustling of leaves	20		
Broadcasting Studio	10		
Threshold of Human Hearing	0	Very Faint	

<sup>a</sup> Note that both the subjective evaluations and the physiological responses are continuums without true threshold boundaries. Consequently, there are overlaps among categories of response that depend on the sensitivity of the noise receivers.

Source: EPA (1974) and others.

#### **4.7.1.2 Operational Impacts: Methods of Noise Analysis**

##### **Green Line Train Noise Modeling**

The Green Line operational noise impact assessment was conducted using the Federal Highway Administration (FHWA) Traffic Noise Model (TNM v. 2.1 - USDOT 2003). This tool is the latest available computer model developed by FHWA for assessing noise from line sources such as roads. Using this tool, noise from the Green Line was estimated based on monorail trains running on elevated guideways along the alternative alignments. This approach was developed based on source-specific sound level measurements of a Bombardier Mark VI monorail in use at Walt Disney World in Orlando, Florida. This modeling used varying numbers of light-duty vehicles to simulate the operation of the Green Line at projected varying travel speeds along the alignment alternatives (excluding SODO, where there are no sensitive receivers).

The Traffic Noise Model (TNM) calculates hourly Leqs due to line sources and can consider effects of terrain, the presence of obstacles that can impede sound transmission, and the effects of varying ground types between the source and the receptors. In this instance, the model was used to estimate noise from the Green Line by considering one train traveling in each direction at the average speed in a number of subsections of each alternative Green Line segment. Model results were then scaled up to represent the number of trains expected in each hour of the day. This number was then converted to an Ldn (a 24-hour sound level) that could be compared with both existing sound levels (Table 4.7-5) and with Federal Transit Administration (FTA) impact thresholds (Table 4.7-3). Refer to Appendix R, Noise and Vibration Backup Information, for additional information regarding this modeling and the source sound measurements.

##### Model Receptors

The noise impact modeling examined the five segments of the Green Line alignment alternatives that include residential uses, and so did not consider the SODO Segment. Each segment of the Green Line was further subdivided into smaller sections to consider changes in expected travel speeds along each section. The noise modeling used series of theoretical receptors to represent sensitive receiving locations in each segment. Model receptors were placed to represent three general locations relative to the Green Line guideway as follows: (1) residential locations at the backside of the sidewalk, (2) residential uses set further back from the sidewalk, and (3) second row setback residential properties (i.e., homes at least one-half block from the nearest major road or guideway). Receptor locations were established based primarily on the presence of residential uses and were located as needed on both sides of the guideway. In some cases, additional non-residential-use receptors were employed to examine the potential noise implications in parks and in commercial areas of the various alignments. Receptor locations were held constant with all alternatives to enable comparison of the potential noise implications of the alternative alignments.

#### **4.7.1.3 Regulatory Overview**

The noise impact analysis employed the noise impact criteria developed by the FTA because these criteria are widely used to analyze noise from transit projects. These criteria are explained in the text below and illustrated in Tables 4.7-2 and 4.7-3.

##### **Federal Transit Administration Noise Criteria**

The FTA describes its noise impact criteria for transit projects in the manual entitled *Transit Noise and Vibration Impact Assessment* (FTA 1995). These criteria apply to rail projects, including monorails;

fixed facilities such as transit stations, maintenance facilities, and park and ride lots; and buses traveling on local roads or in bus-only highway lanes.

FTA transit noise impact criteria are based on the land use category of the receiving properties (Table 4.7-2). The criteria for lands with sensitive nighttime uses (i.e., sleeping) are based on the day-night sound level (L<sub>dn</sub>). Criteria for lands with uses confined primarily to daytime activities are based on the hourly Leq of the noisiest hour of transit-related activity, especially during periods of increased sensitivity to noise. FTA noise criteria apply based on the uses of the affected properties, and apply more stringent definitions of impact for residential uses and locations where quiet is the basis for use. Less stringent limits pertain to commercial and other institutional uses that typically do not involve nighttime uses for sleeping.

**Table 4.7-2. Land Use Categories and Metrics for Transit Noise Impact Criteria**

Land Use Category	Noise Metric (dBA)	Description of Land Use Category
1	Outdoor Leq(1) <sup>a</sup>	Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use.
2	Outdoor L <sub>dn</sub>	Residences and buildings where people normally sleep. This category includes homes, hospitals, and hotels, where a nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor Leq(1) <sup>a</sup>	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, and churches, where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Buildings with interior spaces where quiet is important, such as medical offices, conference rooms, recording studios, and concert halls fall into this category, as do places for meditation or study associated with cemeteries, monuments, and museums. Certain historical sites, parks, and recreational facilities are also included.

<sup>a</sup> Equivalent sound level of the noisiest hour of transit-related activity during period of noise sensitivity.

Source: FTA (1995).

FTA noise impact criteria consider both the overall sound levels and the sound level increases that would occur due to a transit project. A simple way to summarize these impact criteria is by comparing noise that would be caused by a project with existing sound levels. Figure 4.7-1 provides a graphic representation of the FTA impact criteria; the specific *impact* and *severe* threshold levels used by FTA are listed in Table 4.7-3. Under these criteria, receiving locations with low existing sound levels can be exposed to relatively more project noise before an impact occurs. Conversely, the relative allowed levels of project-related noise are lower in locations with higher existing sound levels. For example, a residential location with an existing 40 dBA L<sub>dn</sub> would not be considered affected unless project noise would be 15 dBA or more higher than existing, but a location with a 60 dBA L<sub>dn</sub> baseline would be considered significantly affected by a project-related noise level only 3 dBA higher than existing (63 dBA).

The FTA noise policy provided the main criteria used in assessing the potential for impacts from the Green Line. The assessment for receptors representing residential receivers was based on measured and calculated L<sub>dns</sub> (24-hour Leqs with an added nighttime noise weighting) because such locations are used for sleeping. The assessment for parks and commercial receptors was based on the highest measured and calculated hourly Leq.



While the FTA impact criteria shown in Figure 4.7-1 and Table 4.7-3 use the terms *impact* and *severe* to describe the impact thresholds, the relative significance of impacts under these criteria is not specifically defined by FTA. As shown in Figure 4.7-1, the FTA noise impact criteria are delineated by two curves that allow increasing project noise levels as existing noise increases, up to a point. Beyond that point, impact is determined based on the project noise alone. Below the lower curve in Figure 4.7-1, a project is considered to have no noise impact because on average, the project noise will result in an insignificant increase in the number of people highly annoyed by the new noise. The curve defining impact stops at 65 dBA for Category 1 and 2 land uses (parks and residences) because a number of federal agencies consider 65 dBA as the noise limit for an acceptable living environment. Project noise levels above the upper curve in this figure are considered a severe impact because a significant percentage of people would likely be highly annoyed by the new noise. A project noise level between the two curves is an impact under FTA policy, and although not considered severe, may also be significant. Noise in this range would be expected to be noticeable to most people, but may not be sufficient to cause strong adverse reactions from the community. In this transitional area, other factors must be considered to determine the magnitude of the impact and the need for mitigation. These factors include the predicted noise increase over existing levels and the types and numbers of noise-sensitive land uses that would be affected.

Under FTA criteria, locations with high existing sound levels are not considered affected by the introduction of a new noise source that would not increase the existing level more than minimally. For example, at locations where the existing sound level is 10 dBA or more louder than the noise from the Green Line, the existing level would be unaffected by the addition of the new noise. In locations where the difference in levels is less than 10 dBA, the two noise levels would combine to increase the overall level, possibly to the point of being considered an impact. In locations where the level from a new noise source is the same as existing noise, the overall sound levels would increase by 3 dBA. Under FTA criteria, the determination of impact is based on the overall sound level that would result from the addition of the new noise, and whether that level rises to a level considered an impact. So in some instances where the Green Line noise would be less than existing sound levels, the effect of combining the two levels could increase the overall sound level into the impact range.

The Green Line noise impact analysis used the FTA criteria as the primary basis for assessing the relative significance of noise related to the proposed project alternatives and defined impacts as follows. All potential impacts to non-residential use properties are considered *moderate* impacts because of the temporary exposure for most people using such facilities and the fact that sleep disturbance would not be an issue. Green Line generated sound levels affecting residential uses in areas where the resulting sound levels would remain less than about 65 dBA L<sub>dn</sub> also are considered moderate impacts. In areas where existing sound levels are near or above 65 dBA L<sub>dn</sub>, and where project noise would increase the level more than about 0.5 dBA, and in locations where Green Line noise would cause the cumulative noise level to approach, reach, or exceed 65 dBA L<sub>dn</sub> are considered to have *potential significant impacts*. These terms are used in the following tables and discussions because they are consistent with SEPA designations of the relative significance of potential environmental impacts.

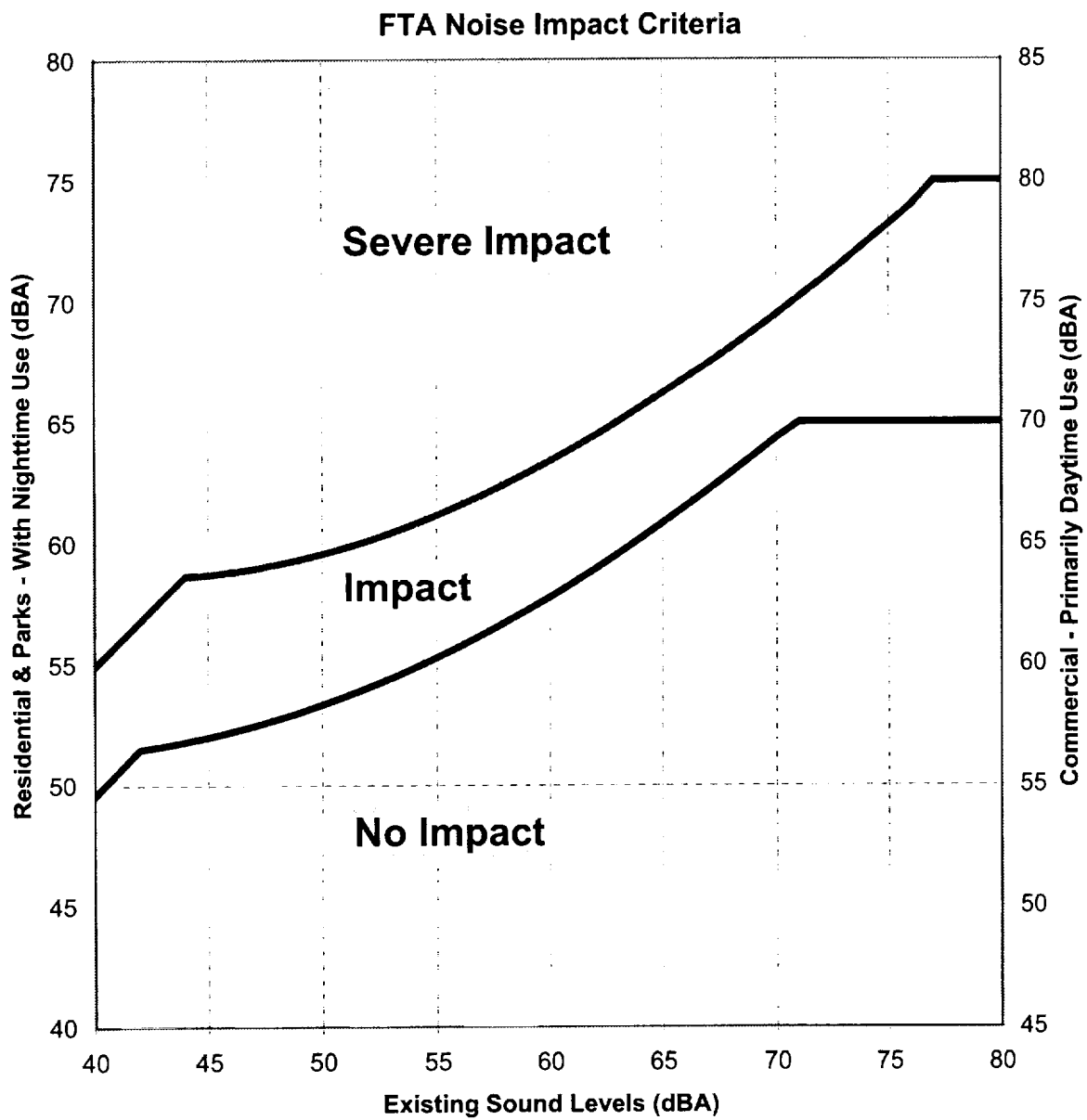


Figure 4.7-1  
FTA Noise Impact Criteria

**Table 4.7-3. FTA Impact Thresholds for Transit Projects (dBA)**

Existing Ldn or Leq	Project-Generated Noise Levels			
	Residential and Other Sensitive Receivers		Commercial Receivers	
	Impact	Severe	Impact	Severe
< 43	Ambient +10	Ambient +15	Ambient +15	Ambient +20
43	52	58	57	63
44	52	58	57	63
45	52	58	57	63
46	53	59	58	64
47	53	59	58	64
48	53	59	58	64
49	54	59	59	64
50	54	59	59	64
51	54	60	59	65
52	55	60	60	65
53	55	60	60	65
54	55	61	60	66
55	56	61	61	66
56	56	62	61	67
57	57	62	62	67
58	57	62	62	67
59	58	63	63	68
60	58	63	63	68
61	59	64	64	69
62	59	64	64	69
63	60	65	65	70
64	61	65	66	71
65	61	66	66	71
66	62	67	67	72
67	63	67	68	72
68	63	68	68	73
69	64	69	69	74
70	65	69	70	74
71	66	70	71	75
72	66	71	71	76
73	66	71	71	76
74	66	72	71	77
75	66	73	71	78
76	66	74	71	79
77	66	74	71	79
> 77	66	75	71	80

Source: FTA (1995) - Table 3-1.

A fairly conservative (i.e., protective) approach was used in assessing the relative significance of potential noise impacts from the Green Line so as to err on the side of caution when identifying potentially adversely affected residential locations. It is worth noting that FTA noise impact criteria are based on levels of noise at outdoor locations, with the assumption that indoor levels will be substantially lower, and therefore suitable for habitation, because of the sound reduction provided by building envelopes. It would likely be possible to provide acceptable indoor sound levels even if outdoor levels are too high by adding to the noise-attenuating properties of the building in question. For example, the use of better windows and/or air conditioning can substantially reduce indoor sound levels caused by outdoor sources, and may be used as a form of mitigation.

### City of Seattle Noise Limits

Noise from construction of the Green Line would be governed by the timing restrictions and the noise limits included in the Seattle noise ordinance (Seattle Municipal Code, Chapter 25.08). This ordinance includes maximum permissible sound levels based on the zoning of the source and receiving properties (upper portion of Table 4.7-4). With these limits as a basis, the ordinance also sets maximum levels and durations of allowable daytime construction noise. The Seattle construction noise limits are displayed in the lower portion of Table 4.7-4.

**Table 4.7-4. Seattle Maximum Permissible Levels and Construction Noise Limits (dBA)**

Zoning District of Noise Source [25.08.410 & 420]	Zoning District of Receiving Property		
	Residential Day/Night	Commercial	Industrial
Residential	55/45	57	60
Commercial	57/47	60	65
Industrial	60/50	65	70
Daytime Construction Noise Limits - at 50' or a real property line, whichever is greater. <i>Construction noise is limited to the higher levels listed below, during daytime hours only, defined as 7 a.m. to 10 p.m. weekdays and 9 a.m. to 10 p.m. weekends. These limits effectively prohibit construction at night except in special cases.</i>			
<i>On-site sources, including dozers, loaders, power shovels, cranes, derricks, graders, off-highway trucks, ditchers, and pneumatic equipment (maximum + 25) [25.08.425 A.1]</i>			
Residential	80	82	85
Commercial	82	85	90
Industrial	85	90	95
<i>Portable equipment used in temporary locations in support of construction, including chain saws, log chippers, and powered hand tools (maximum + 20) [25.08.425 A.2]</i>			
Residential	75	77	80
Commercial	77	80	85
Industrial	80	85	90
<i>Impact types of equipment, including pavement breakers, pile drivers, jackhammers, sand-blasting tools, or other impulse noise sources, may exceed maximum permissible limits between 8 a.m. and 5 p.m. weekdays and 9 a.m. and 5 p.m. weekends, but may not exceed the following limits [25.08.425 B]:</i>			
Leq(1 hr) - 90 dBA	Leq(30 minutes) - 93 dBA	Leq(15 minutes) - 96 dBA	Leq(7.5 minutes) - 99 dBA

Source: Seattle Municipal Code - 25.08 - Specific sections indicated.

Section 25.08.425C of the Seattle Municipal Code also prohibits construction noise from exceeding the maximum permissible sound levels in Table 4.7-4 in the interior of buildings in commercial districts

between the hours of 8:00 a.m. and 5:00 p.m. Compliance with this requirement is intended to be assessed after every reasonable effort, including but not limited to closing windows and doors, has been taken to reduce such noise in the interior space.

Noise from operation of transportation sources is typically exempt from the property-line noise limit provisions of most noise ordinances, which measure the noise from a source property in a particular zone (residential, commercial, or industrial) within a receiving property that may be in another zone. Instead, transportation noise is typically controlled with specific limits using performance standards for levels from new vehicles that can be reasonably met by automobile, bus, and motorcycle manufacturers. The Seattle noise ordinance uses this approach and adopts specific standards for most transportation sources such as new cars, buses, and motorcycles. However, the Seattle ordinance does not have performance standards specific to rail uses such as trolleys, light rail, or monorail. Therefore, the more typically applicable FTA noise impact criteria have been used in this analysis because those criteria provide objective and nationally recognized standards for assessment of impacts for transit projects.

#### 4.7.1.4 Existing Acoustic Environment

The character of the existing acoustic environment in and near the project corridor was assessed with a series of sound level measurements (SLMs) at locations representing sensitive receivers. These 24-hour measurements document the range of sound levels that occurred over the course of the day of the measurements, and so provide an indication of typical levels in areas that could be affected by monorail noise. All measurements were taken using Type 1 sound level equipment that had been factory certified within the previous 12 months. The SLMs are summarized in Table 4.7-5, and the measurement locations are depicted on Figures 4.7-5 through 4.7-8 included in Section 4.7.2.2.

**Table 4.7-5. Measured Existing Sound Levels Representing Residential Receivers (dBA)**

Measurement Location	SLM Date	Range of Measured Hourly Leqs		Range of Measured Hourly Lmax		Calculated Ldn
		Daytime	Nighttime	Daytime	Nighttime	
SLM1: 8351 15 <sup>th</sup> Avenue NW	3/31/03	67-72	59-71	79-99	76-92	73.2
SLM2: 7325 15 <sup>th</sup> Avenue NW	2/11/02	64-70	57-67	77-91	74-91	70.2
SLM3: 6712 16 <sup>th</sup> Avenue NW	3/31/03	55-60	45-58	68-79	65-72	60.3
SLM4: 3821 14 <sup>th</sup> Avenue W	4/7/03	61-65	56-64	68-80	66-84	66.9
SLM5: 505 W Mercer Place	3/26/03	65-70	61-68	72-86	69-84	71.4
SLM6: Second Ave & W Harrison St	2/8/02	55-60	48-56	72-82	64-75	60.5
SLM7: Near 2218 Fifth Avenue	3/31/03	67-78	58-76	82-104	77-103	76.5
SLM8: 2334 Second Avenue	2/9/02	57-64	54-62	71-92	68-86	65.8
SLM9: Pigeon Point	5/19/03	70-74	62-73	81-95	79-94	75.6
SLM10: 2803 SW Yancy Street	3/26/03	59-64	48-58	77-88	65-77	62.6
SLM11: 3249 SW Avalon Way	1/15/02	65-72	52-67	83-101	75-86	69.9
SLM12: 5948 California Avenue SW	3/26/03	62-66	50-62	74-81	70-82	65.5
SLM13: 6708 California Avenue SW	3/31/03	63-69	52-66	75-91	72-80	68.3

Source: Sound level measurements by MFG, Inc. and SSA Acoustics.

As shown in Table 4.7-5, existing sound levels near almost all portions of the Green Line project area are fairly high. Existing levels at all locations were dominated by traffic noise from nearby roads.

## Seattle Center Sound Level Measurements

In addition to the daylong sound level measurements at locations representing residential uses along the Green Line corridor, short-term sound level measurements were taken at outdoor locations at the Seattle Center. These measurements provide indications of existing levels at these outdoor use areas both with and without events at the Seattle Center. These measurements are summarized in Table 4.7-6.

**Table 4.7-6. Measured Existing Sound Levels at Seattle Center at Various Times (dBA)**

Location	Center Event	Date	Start Time	Duration	Leq	Lmax
Near Fisher Pavilion Roof	None	4/25/03	10:43 <sup>a</sup>	1 hour	57.5	93.1
Fisher Pavilion Roof	Folklife Festival	5/24/03	14:48 <sup>b</sup>	15 min	69.3	84.1
			17:40 <sup>c</sup>	15 min	68.7	94.1
Mural Amphitheater (near center of audience space)	None	4/25/03	9:38	1 hour	58.8	79.0
	Rhythm Festival	4/26/03	11:46 <sup>d</sup>	15 min	55.8	68.3
	Folklife Festival (during performances)	5/24/03	14:22	15 min	81.0	96.6
			18:05	15 min	80.1	97.6
			18:20	15 min	82.6	96.5
Near Northwest Rooms	None	4/25/03	12:01	20 min	57.2	88.2
	Folklife Festival (during performances)	5/24/03	13:19	15 min	79.2	92.0
			13:35 <sup>e</sup>	15 min	70.0	80.8
			16:32	15 min	79.9	92.7
			16:48	15 min	76.1	90.3
Lawn Locations Near International Fountain	None	4/25/03	12:09 <sup>f</sup>	20 min	64.9	78.6
	Rhythm Festival	4/26/03	11:26 <sup>d, g</sup>	15 min	55.0	84.6
			18:34 <sup>g</sup>	15 min	72.9	102.5
	Folklife Festival	5/24/03	12:56 <sup>g</sup>	15 min	74.5	91.9
			16:10 <sup>g</sup>	15 min	77.8	90.1

<sup>a</sup> Roof area of Fisher Pavilion was not yet finished. SLM was taken near south edge of roof area.

<sup>b</sup> Near performance venue, but with no performance activity.

<sup>c</sup> With spoken performance at nearby venue.

<sup>d</sup> During World Rhythm Festival, but without any activity at this venue or nearby; used as background level.

<sup>e</sup> Between performances at nearby stage.

<sup>f</sup> On lawn east of fountain; included sound from fountain, people nearby, and some limited construction noise.

<sup>g</sup> On lawn north of fountain, with varying levels of activities nearby.

Source: Sound level measurements by MFG, Inc.

### 4.7.1.5 Vibration Standards and Criteria

The evaluation of vibration impacts uses standards and criteria developed by the Federal Transit Administration (FTA) for assessing vibration impacts related to transit projects. These standards are outlined in *Transit Noise and Vibration Impact Assessment* (FTA, Final Report, April 1995). The *Transit Noise and Vibration Impact Assessment* is the only standard for evaluating vibration impact from operation and construction of a wide range of mass transit projects. No local ordinance addresses structural vibration impact limits for mass transit systems.

The effects of ground-borne vibration from monorail trains to adjacent properties along the Green Line alignments are evaluated. This section focuses primarily on the impacts of operation of Green Line trains; construction impacts are discussed in Section 4.17, Construction. The FTA guideline defines acceptable vibration levels depending on the land use category of the adjacent properties for frequent events and provides recommendations for vibration levels not to be exceeded during construction when historic buildings are in close proximity.

Design criteria have been established for High Sensitivity, Residential, Institutional Land Use, Special Buildings, and underground utilities, as well as for construction impacts. The basic concept of ground-borne vibration is that the train tires rolling on the guideway beams create vibration energy that is transmitted through the support structure and into the foundation. The vibration of the foundation creates vibration waves that propagate through adjacent soil and rock strata to the foundation of nearby buildings. The vibration propagates from the foundation throughout the remainder of adjacent building structures.

The vibration criteria for frequent events (more than 70 per day) for different land use categories defined by FTA Guidelines include:

- **Vibration Category 1: High Sensitivity** – Includes buildings where low ambient vibration is essential for the operations within the building. Typical land uses include sensitive research and manufacturing businesses, hospitals with vibration-sensitive equipment, and university research operations. The ground-borne vibration impact limit is 65 VdB re 1 micro inch/sec.
- **Vibration Category 2: Residential** – Includes all residential land uses and any building where people sleep, such as hotels and hospitals. The ground-borne vibration impact limit is 72 VdB re 1 micro inch/sec.
- **Vibration Category 3: Institutional** – Includes schools, churches, other institutions, and quiet offices that do not have vibration-sensitive equipment, but still have the potential for activity interference. The ground-borne vibration impact limit is 75 VdB re 1 micro inch/sec.
- **Vibration Criteria for Special Buildings** – Includes concert halls, TV and recording studios, auditoriums, and theaters.

Concert Halls	Ground-borne vibration impact limit is 65 VdB re 1 micro inch/sec.
TV Studios	Ground-borne vibration impact limit is 65 VdB re 1 micro inch/sec.
Recording Studios	Ground-borne vibration impact limit is 65 VdB re 1 micro inch/sec.
Auditoriums	Ground-borne vibration impact limit is 72 VdB re 1 micro inch/sec.
Theaters	Ground-borne vibration impact limit is 72 VdB re 1 micro inch/sec.

- **Construction Vibration Threshold Criteria** – Includes Historic Buildings

Fragile Buildings	Ground-borne vibration impact limit from construction activities is 100 VdB re 1 micro inch/sec.
Extremely Fragile Buildings	Ground-borne vibration impact limit from construction activities is 95 VdB re 1 micro inch/sec.

Extremely fragile buildings include historic brick buildings with a high risk of cracking. The construction vibration impact limits are approximate thresholds above which architectural damage could occur in some of the extremely fragile buildings.

#### **4.7.1.6 Existing Vibration Measurements**

The Green Line is an elevated street railway that would have rubber-tired vehicles traveling along elevated guideway beams supported by columns. Concrete pre-cast guideways would have a 5- to 7-foot depth and span between approximately 60 to 150 feet or greater for bridges or other special structures where needed. Expansion columns with expansion gaps between sections of guideway would be designed every third to sixth column to absorb dimensional changes, such as those caused by thermal expansion. Column foundations would be between 6 to 12 feet in diameter, with depths varying from 30 to greater than 100 feet depending on subsurface conditions. Green Line vehicles would travel at a maximum speed of 50 mph.

It would be unusual for an elevated transportation systems using pneumatic rubber tires to produce ground-borne vibration that would exceed FTA standards. The smoothness of the concrete guideway and the distance of the support structure to the closest receiver are the critical factors. The rubber tires plus the concrete columns together with ground damping (depending on soil type and conditions) and coupling losses between the ground and the foundation would provide a high degree of vibration damping.

This section analyzes structural vibration impacts from Green Line operation using the FTA standards for comparison purposes. Construction impacts are analyzed in Section 4.17, Construction. The study uses vibration data collected from the existing Seattle Center Monorail system as the vibration source levels with no reduction for new train or guideway design. Using the existing Seattle Center Monorail for vibration source data results in a conservatively high estimate of vibration impacts from the Green Line operations because existing monorail vehicles are over 40 years old, and newer vehicle technology would generate less vibration. In addition, modern construction techniques of the Green Line guideway would result in smoother and less frequent expansion gaps between sections of guideway compared to the existing monorail system, also resulting in lower vibration. The existing Seattle Center Monorail has expansion gaps at every column compared to every three to six columns for the proposed Green Line. Monorail vehicles traveling over these expansion gaps create the largest vibration levels based on the source data collected.

#### **4.7.1.7 Vibration Measurement Setup and Descriptors**

Existing vibration measurements of the existing Seattle Center Monorail system were taken to establish source levels for structural vibration. The measured vibration levels are a conservatively high estimate of the future vibration impact from the Green Line trains. Improvements to the train's suspension system and guideway construction will reduce the overall vibration levels for new monorail systems, due primarily to the smoothness of the guidebeam surface and the reduced number and size of the expansion gaps, which are the main sources of vibration. In addition, all measurements have been taken at a maximum speed of 50 mph for the impact analysis. In most locations, the Green Line trains would be traveling at lower speeds, thereby generating lower vibration levels than analyzed using the source data in this section.



A 01dB Symphony Spectrum Analyzer Serial Number #51 with Dytran transducers (including magnetic bases Serial Number #3055A2 107 and 108) was used for the measurements. The system was calibrated before and after each measurement using 1557-A Vibration Calibrator General Radio Serial #2146.

All measurements are root mean square (RMS) velocity levels expressed in velocity dB, abbreviated VdB. Vibration velocity levels in decibels are defined as:

$$Lv = 20 \times \log_{10} (V/V_{ref})$$

Lv - velocity level in VdB  
V - RMS velocity amplitude  
Vref - reference velocity amplitude

The reference vibration velocity used throughout this section is 1 micro inch per second (micro inch/sec).

Because the net average of a vibration signal is zero, RMS amplitude is used to describe the smoothed vibration amplitude. The RMS of a signal is the average of the squared amplitude of the signal. The average is typically calculated over the measurement period, similar to how the human body responds to an average vibration amplitude.

Although the vibration perceptibility threshold is about 65 VdB, human response to vibration is not usually significant unless the vibration exceeds 70 VdB (Figure 4.7-2).

- |        |   |
|--------|---|
| 65 VdB | Approximate threshold of perception for many humans.  |
| 75 VdB | Approximate dividing line between barely perceptible and distinctly perceptible. Many people find transit vibration at this level unacceptable. |
| 85 VdB | Vibration acceptable only if there are an infrequent number of events per day.  |

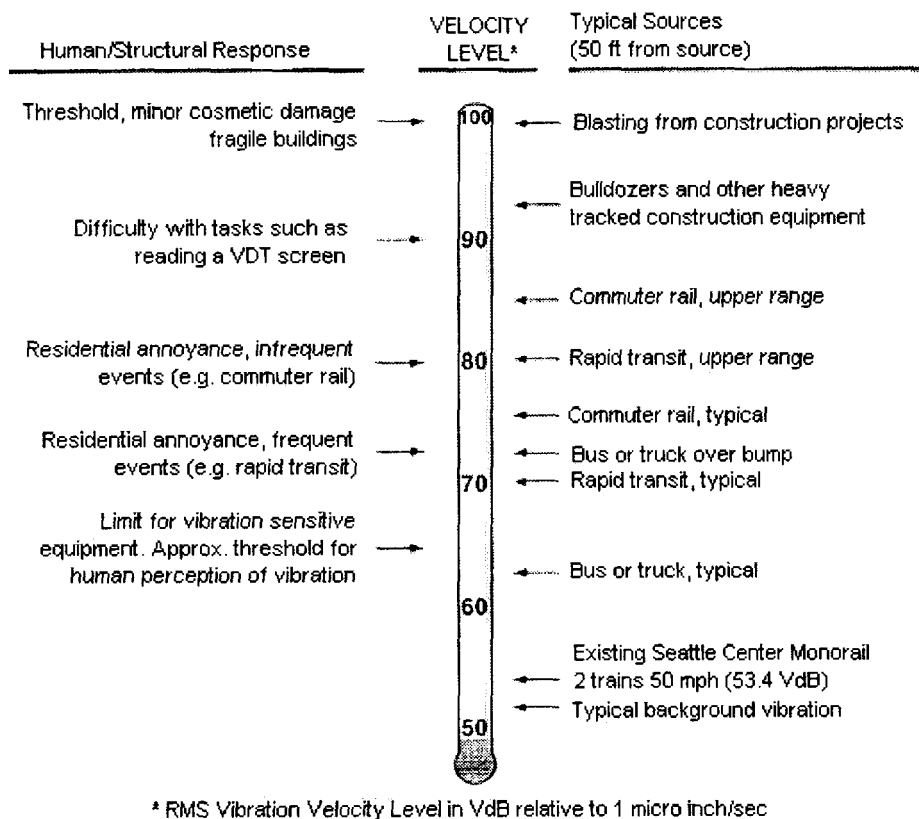
All transducers used for the vibration measurements were attached using magnetic bases coupled to a 2-by 2-inch steel plate and glued to the measured surface with industrial adhesive. The surfaces were clean and flat to provide optimal coupling between the transducers and test surfaces. Measurements were conducted with two transducers simultaneously.

Measurements along the existing monorail were taken on April 3, 2003. A summary of the results is presented in Table 4.7-7. A comprehensive set of vibration measurements for different system operating characteristics was taken as follows:

- At maximum vehicle speed (50 mph) at a guideway discontinuity (expansion gap).
- At a turn with the train going 30 mph.
- At a station with the train at maximum braking and acceleration.
- At different distances from the support column to assess how much source vibration is transmitted through support columns and into the adjacent ground.

The vibration velocity levels of typical sources would increase by 12 VdB re 1 micro inch/sec if the distance between source and receiver is reduced to 10 feet.

**Figure 4.7-2. Typical Levels of Ground-Borne Vibration**



Source: *Transit Noise and Vibration Impact Assessment* (FTA, Final Report, April 1995).

Measurements taken on top of the guideway support column with the train at maximum speed (50 mph) passing an expansion gap showed the highest vibration levels and have been used for the vibration impact predictions. The vibration damping levels measured at different distances away from a support column were found to be higher than published data. Therefore, these measurement results have not been used for the vibration impact assessment. Instead, the published "Generalized Ground Surface Vibration Curves" from the FTA Guidelines have been used to provide a conservatively high estimate of vibration impacts.

Projected vibrations were developed based on measurements of existing monorail vehicles approaching and departing a station and were adjusted to reflect typical maximum speeds (50 mph) for the Green Line. Basing the analysis on train speeds of 50 mph is very conservative, as the average speed of the Green Line trains will be lower at most locations and therefore would also generate lower vibration impact than the model predictions.

**Table 4.7-7. Existing Seattle Monorail Vibration Levels**

Location	Vibration Level (VdB)	
	Ambient	with Train at 50 mph
Guideway/expansion gap	53.6	78.2
Column base	55.7	68.0
5 feet from base	53.3	62.9
10 feet from base	53.2	59.4
20 feet from base	51.8	53.3
30 feet from base	52.1	52.4
40 feet from base	50.7	50.9
50 feet from base	51.2	51.3
100 feet from base	49.8	49.8
Mid span between columns 38 and 39	58.7	72.3
Turn/expansion gap	54.1	74.4
Station EMP maximum braking	55.3	68.8
Station EMP maximum acceleration	55.3	68.9

Note: All measurements were taken for a duration of 30 seconds.

#### **4.7.1.8 Methodology for Estimating Vibration from Green Line Operations**

To estimate vibration levels from Green Line operations, a scenario reflecting the maximum possible vibration levels was developed. This scenario assumed two trains passing a column with expansion gaps simultaneously at a maximum speed of 50 mph. Existing vibration measurements have identified a train passing the expansion gaps as being the most severe vibration impact from Green Line operations. Predictions of ground-borne vibration levels at different distances from the centerline of the track are shown in Table 4.7-8.

**Table 4.7-8. Predicted Source Vibration Levels**

Description	Direction	Vibration Level
Two trains at 50 mph in opposite directions at guideway/expansion gaps	Vertical	84.2 VdB
Column base with two trains at 50 mph	Vertical	74.0 VdB
5 feet from face of base with two trains at 50 mph	Vertical	69.4 VdB
10 feet from face of base with two trains at 50 mph	Vertical	65.4 VdB
20 feet from face of base with two trains at 50 mph	Vertical	61.4 VdB
30 feet from face of base with two trains at 50 mph	Vertical	58.4 VdB
40 feet from face of base with two trains at 50 mph	Vertical	55.4 VdB
50 feet from face of base with two trains at 50 mph	Vertical	53.4 VdB
100 feet from face of base with two trains at 50 mph	Vertical	46.4VdB

RMS velocity levels, VdB re 1 micro inch/sec.

The predicted vibration levels in Table 4.7-8 are a conservatively high estimate of vibration levels from Green Line operations. The impact scenario evaluates the maximum theoretical vibration impact from two trains under the above conditions. In reality, it would be very unlikely for two Green Line trains to

simultaneously pass a column with expansion gaps at the maximum 50 mph speed. This maximum speed can only be achieved on long, straight guideway sections with long enough spacing between stations to provide sufficient distance for accelerating and braking.

During the majority of time during Green Line operations, the structural vibration levels would be well below the stated maximums shown in Table 4.7-8. For example, one train going over an expansion gap would lower vibration levels by 6 VdB re 1 micro inch/sec compared to two trains passing at the same time. In addition, newer train technology and construction methods with smoother surfaces and fewer and smaller expansion gaps would further reduce the stated vibration levels compared to the measurements taken on the existing monorail (the expansion gaps on the existing Seattle Center Monorail are relatively large and worn out due to brittle concrete).

Predictions for vibration damping with distance have been taken from the *FTA Transit Noise and Vibration Impact Assessment, Final Report* April 1995, Figure 10-1, "Generalized Ground Surface Vibration Curves" for Rubber-Tired Vehicles (30 mph). The curves in Figure 4.7-3 have been developed from numerous measurements of ground-borne vibration levels from rubber-tired vehicles at different distances, in different subsoil conditions. The curves represent the upper range of the measurement data, which means that although actual vibration levels show a 10 VdB re 1 micro inch/sec fluctuation depending on the subsurface conditions and coupling effects, it is rare that ground-borne vibration would exceed the vibration levels shown in these curves. Exceedances have only been documented in extenuating circumstances, such as rail corrugations or wheel flats not applicable for rubber-tired systems such as a monorail. As ground damping values do not change with the speed of a vehicle, the curve for rubber-tired vehicles at 30 mph can be applied to a system with 50 mph train speeds.

Damping versus distance values have been established for various setbacks from the Green Line using Figure 4.7-3. These values have been used to develop the predicted vibration impact levels at different distances from the alignment shown in Table 4.7-8. The source levels for Table 4.7-8 have been taken from the actual measurements at the column base of the existing monorail. Predicted future ground-borne vibration levels from the Green Line are shown in Figure 4.7-4. The predicted vibration levels stated in Figure 4.7-4 are conservatively high since the vibration levels assumed two trains passing over an expansion gap at the same time, at higher speeds than the Green Line would typically use, and used measurements from the 40-year-old existing Seattle Center Monorail. The actual vibration levels from the Green Line operation would be lower at almost all times and locations.

#### **4.7.1.9 Inventory of Vibration-Sensitive Sites**

The following buildings located in close proximity to one or more Green Line alternative alignments have been identified as land uses with a high sensitivity to structural vibration. The FTA vibration impact criteria have been used to identify sensitive receivers as specified in Vibration Category 1, High Sensitivity and Special Buildings.

**Vibration Category 1: High Sensitivity** – Included in Category 1 are buildings where low ambient vibration is essential for the operations within the building, which may be well below levels associated with human annoyance. Typical land uses covered by Category 1, High Sensitivity, are vibration-sensitive research and manufacturing, hospitals with vibration-sensitive equipment, and university research operations.

**Vibration Criteria for Special Buildings** – There are some buildings that do not fit into the High Sensitivity category, but because of the sensitivity of the buildings, they usually warrant special attention. Typical buildings covered by Category 2, Special Buildings, are concert halls, TV and recording studios, and theaters.

**Figure 4.7-3. General Ground Surface Vibration Curves**

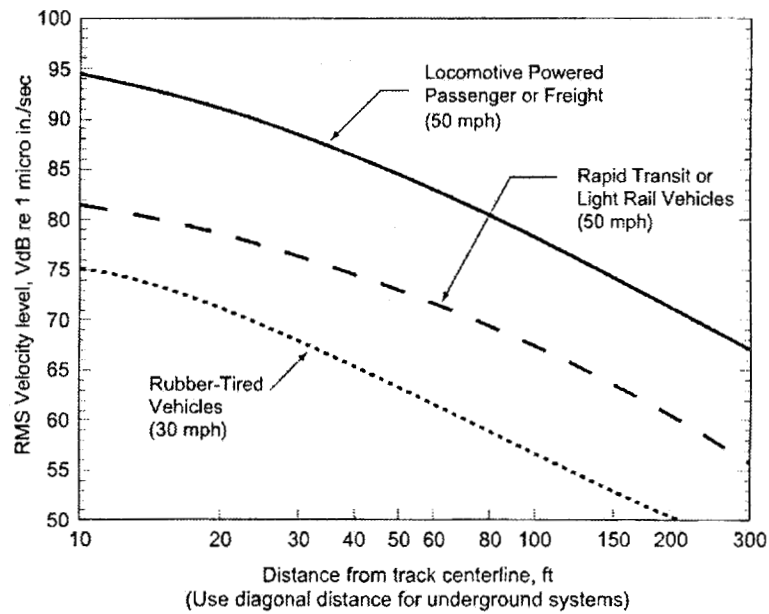
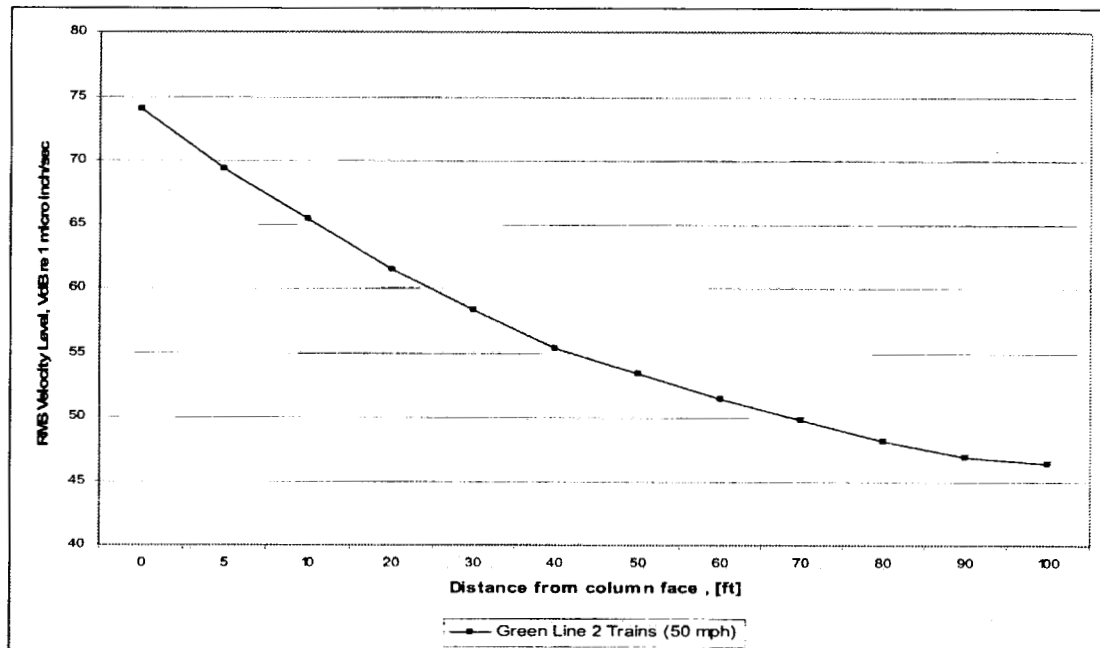


Figure 10-1 Generalized Ground Surface Vibration Curves

Source: FTA "Transit Noise and Vibration Curves" for Rubber-Tired Vehicles.

**Figure 4.7-4. Ground Surface Vibration Curve for the Green Line**



There are two High Sensitivity buildings along the Green Line alternative alignments, both located in the Interbay Segment:

- Friedman & Bruya, Inc. Environmental Chemists at 3012 16<sup>th</sup> Avenue W. This building is located south of W Dravus Street and is approximately 20 and 100 feet away from alignment Alternatives 2.1 and 2.2, respectively.
- Immunex/Amgen Campus at 1555 W Galer Street. This campus is located west of Elliott Avenue W south of the Magnolia Street Bridge and Galer Street overpass. The campus is approximately 250 to 200 feet away from alignment Alternatives 2.1 and 2.2, respectively.

Other facilities defined as Special Buildings located in close proximity to the Green Line alternative alignments include:

- Marion Oliver McCaw Hall at Seattle Center
- Seattle Repertory Theater at Seattle Center
- Intiman Playhouse at Seattle Center
- Seattle Children's Theater at Seattle Center
- Experience Music Project (EMP) at Seattle Center
- Fisher Pavilion at Seattle Center
- Moore Theater in Downtown Seattle
- Seattle Art Museum in Downtown Seattle
- Benaroya Hall in Downtown Seattle
- Arts West Theater in West Seattle

In addition to these High Sensitivity and Special Buildings, historic structures listed or eligible for listing in the National Register of Historic Places (NRHP) and City of Seattle landmark properties adjacent to the Green Line alternative alignments were also evaluated for construction vibration impacts.

Historic buildings can be categorized into Extremely Fragile Buildings and Fragile Buildings; however, not all historic buildings listed or eligible for listing in the NRHP are fragile. The FTA Guidelines Final Report from April 1995 does not provide specific guidance on how to define and categorize Fragile or Extremely Fragile Historic Buildings. From experience of similar projects and a seismic classification of different types of structures, the following categories have been assumed for this analysis:

- Extremely Fragile Buildings – Un-reinforced masonry, large un-reinforced concrete block, and old load-bearing timber structures with preexisting cracks in facade, with missing pieces of brick or plaster. Overall bad conditions, not well maintained property.
- Fragile Buildings – Un-reinforced masonry, large un-reinforced concrete block, load-bearing timber structures. No visible cracks in facade, well maintained, overall good condition.
- Not Fragile Buildings – Pre-cast concrete, well-maintained wood, or steel structures.

All historic properties have been evaluated and categorized using drawings where available and visual inspection. A list of historic buildings including classification is included in Table 4.17-6, Historic Resources and Construction Vibration Impact from Pile Driving.

## 4.7.2 Impacts

### 4.7.2.1 Operational Noise Impacts Related to Green Line Stations

Noise sources at Green Line stations would include the stopping and starting of trains, onboard equipment, and people entering and leaving the trains. As Green Line trains enter and leave stations, they must brake and then accelerate. With properly functioning trains, the process of starting and stopping does not generate much if any excess noise because the trains are powered by electric motors, and there is no engine noise as there is with equipment powered by internal combustion. In addition, stopping and starting are very short-term events.

When Green Line trains are not moving, there would be no noise related to tire movement, which is the primary noise source at speed. So while stopped at stations, the only noise from a train would be generated by onboard compressors that provide air to pressurize the hydraulic systems (e.g., for opening and closing the doors) and by the heating, ventilation, and possible air-conditioning (HVAC) systems. Each car would be equipped with compressors, but may or may not have HVAC systems. While the compressors and HVAC systems generate fairly low levels of noise that would probably be unnoticed by most users passing through the stations, this equipment generates sufficient noise to be potentially problematic at residential uses very near the stations. Based on the source noise measurements of the Disney World monorail described previously, the estimated noise from a stopped Green Line train is 51 dBA L<sub>dn</sub> at a distance of 50 feet. Using this estimate, it is possible to calculate the approximate levels of noise from a stopped train at more distant locations like the off-site residences as described below.

Potential noise impacts from trains stopped at stations were assessed by screening the alternative station locations to identify the presence of nearby sensitive receivers (residences). For purposes of this screening, a distance of about 160 feet from the center of the station was used. (Refer to Appendix R, Noise and Vibration Backup Information, for more information.) After screening eliminated station locations with no nearby potentially affected receivers, a more detailed station noise analysis was used to identify potentially affected receiving locations. For this secondary analysis, the running Green Line train sound levels predicted with the Traffic Noise Model were added to the estimated idling noise from each station to determine the overall Green Line train-related sound levels at nearby sensitive receivers. This overall monorail noise was then compared to the FTA impact criteria based on the representative existing L<sub>dn</sub> at each location. This analysis determined that the estimated Green Line train sound levels at residential locations near the vast majority of stations would either not be affected by idling noise, or would not experience a noise impact from the combined running and stopped noise. Only two potential station locations were identified as having residential locations nearby that could be affected by the inclusion of stopped Green Line train noise. These two stations are shown in Table 4.7-9.

**Table 4.7-9. Estimated Noise Levels Near Two Alternative Monorail Stations (dBA)**

Station	Existing L <sub>dn</sub>	Station Idling Noise	Running Noise (from TNM)	All Green Line Train Noise (Idling + Running)	FTA Impact Level
Fifth and Stewart 3 (Lenora)	74	60	65	66	66
Pike 1	66	56	60	62	62

Source: MFG, Inc.

The overall noise level at the residential receivers closest to both these locations just exceeds the FTA impact level. Note that the estimates of idling noise are conservative, and the actual overall Green Line sound level may be lower than shown for the following reasons.

- The moving train noise estimated by the Traffic Noise Model (TNM) did not include the trains slowing to a complete stop at the stations. Therefore, the predicted running noise sound levels very near the stations are somewhat overestimated.
- The Green Line stations may themselves include some amount of structure that could obstruct noise transmitted from the stopped trains to the potentially affected residences. Because detailed design information for the stations was not available at the time of this analysis, it was not possible to conclusively determine any potential barrier reductions.
- The train that provided the basis of the equipment noise levels while stopped did not represent the same level of technology in either the noisy equipment (e.g., compressors and pumps) or the sound control applications that are available today.
- Idling noise measured from existing systems includes some elements (such as air conditioning) that may not be included on the Green Line.

### **Station Bus Layover Areas**

All stations also would be serviced by nearby bus routes, and in some instances, bus routes and bus layover areas would be modified to improve service to Green Line passengers. (Bus layovers are already commonly used in many areas along the Green Line alternative alignments.) This would in some cases relocate bus traffic and bus stop zones near the stations and would create new bus stops and new bus layover areas. Such facilities could have noise impacts on nearby residential uses.

Based on review of all the potential bus layover areas, it was concluded that noise from buses at four of the possible layover areas associated with three stations has the potential to impact nearby residential receivers. These include the layover areas associated with the Delridge 1 station, the Avalon 2 station, and the Alaska Junction 2 station. Potential noise impacts associated with these three possible facilities were assessed using the FTA transit noise assessment spreadsheet and representing the layover areas as "transit centers." It was assumed this calculation treated the bus sources as pass-through traffic that included some amount of idling. This would be a reasonable representation of the layover area operation unless such layovers do not occur during all hours of the day. The results of this review are described below.

Delridge 1 (26<sup>th</sup>): This bus layover area would be approximately 60 feet from the nearest residences just south of the possible layover area. Up to seven buses could access this location at any one time. Assuming seven buses per hour would use the layover area each hour between 5:00 a.m. and midnight, the FTA spreadsheet predicts an L<sub>dn</sub> of 62 dBA at the nearest residences. This could constitute a potentially significant noise impact according to FTA criteria, depending on the levels of existing noise at these residences. This potential noise impact will require further assessment if this facility is chosen as part of the Green Line. Such impacts could very likely be controlled by site design and timing considerations (e.g., the actual layover area location, possible noise barrier, and whether buses idle for prolonged periods).

This bus layover area would be located outside the current street right-of-way, so noise from this facility could be subject to the City of Seattle noise limits. The site is zoned for industrial uses and the receiving residences are in a residential zone, so the day and night noise limits are 60 and 50 dBA, respectively. Given that the Green Line is expected to operate during nighttime hours (i.e., between 10:00 p.m. and midnight and between 5:00 and 7:00 a.m.), the more stringent noise limit would be the nighttime limit of



50 dBA. The calculated hourly Leq, assuming seven buses use the layover area in any one-hour period, is 59 dBA. This predicted hourly sound level exceeds the 50-dBA nighttime limit, and noise mitigation would likely be necessary to meet the City noise limits if this site is chosen. The possible mitigation measures mentioned in the preceding paragraph also would be effective in allowing noise from this facility to meet the Seattle noise limits.

Avalon 2 (35<sup>th</sup>): This bus layover area could be on 36<sup>th</sup> Avenue SW, approximately 25 feet from an apartment building with 28 units. Up to four buses could use this area at any one time. Assuming four buses per hour would use the layover area between 5:00 a.m. and midnight, the FTA spreadsheet estimates an Ldn of 70 dBA at the nearest residences. This could constitute a potentially significant noise impact using FTA criteria, depending on existing sound levels at these residences. If the layover area were located on 34<sup>th</sup> Avenue SW instead of 36<sup>th</sup> Avenue SW, the distance from the residences would increase to 38 feet, and the estimated Ldn is 65 dBA. This would reduce the potential for significant noise impacts. These possible noise impacts will require further assessment and possibly mitigation if these layover areas are chosen as part of the Green Line.

Alaska Junction 2 (44<sup>th</sup>/California): This bus layover area could be as close as 35 feet to the nearest residence. Up to three buses could use the site at any one time. Assuming three buses per hour would use the layover area between 5 a.m. and midnight, the FTA spreadsheet estimates an Ldn of 65 dBA at the nearest residences. This could constitute a potentially significant noise impact under FTA criteria, depending on the levels of existing noise at these residences. This potential noise impact will require further assessment and possible mitigation measures if this facility is chosen as part of the Green Line.

### **Traction Power Substations**

The Green Line would use traction power substations along the route to provide electrical power to the monorail. These units are small power substations, and thus involve transformers that emit noise. The power equipment at each substation would be completely enclosed in a masonry building, and thus would not emit more than minor amounts of transformer noise to the outdoor environment. For that reason, noise from these units would not be expected to cause noise impacts.

These traction power substations also could require the use of cooling or ventilation equipment that would generate noise. Noise from such equipment would be controlled to the extent necessary to comply with the applicable sound level limits in the Seattle noise rule.

#### **4.7.2.2 Operational Noise Impacts From Green Line Alternatives**

##### **Segment 1: Ballard Segment**

The Ballard Segment of the Green Line was considered as four subsections based on the varying average speeds across the segment. The modeling results for Segment 1 are summarized in Table 4.7-10 and discussed following the table. The modeling receptors considered in this table are displayed in Figure 4.7-5. The potential for impacts is indicated in the columns labeled "Modeled Impact" in which the calculated monorail noise is compared with FTA noise impact criteria. Cells marked as either *Moderate* or *Potentially significant* denote locations that could be affected by noise from the Green Line. The approximate numbers of residential units affected by project alternatives are summarized in Table 4.7-15 at the end of the discussion of impacts in this section.

**Table 4.7-10. Impact Analysis Results - Ballard Segment**

Segment Subdivision	Receptor #	Existing Ldn	Alternative 1.1		Alternative 1.2	
			Monorail Leq/Ldn	Modeled Impact	Monorail Leq/Ldn	Modeled Impact
NW 85 <sup>th</sup> Street to NW 80 <sup>th</sup> Street 25 mph	1	73	54	No Impact	51	No Impact
	2	72	64	No Impact	55	No Impact
	3	60	54	No Impact	52	No Impact
	4	72	55	No Impact	55	No Impact
	5	55	51	No Impact	51	No Impact
NW 80 <sup>th</sup> Street to NW 65 <sup>th</sup> Street 50 mph	6	72	74	Potentially significant	65	No Impact
	7	70	66	Potentially significant	62	No Impact
	8a	60	60	Moderate	53	No Impact
	8b	72	65	No Impact		No Impact
	9	72	63	No Impact	65	No Impact
	10a	56	59	Moderate	60	Moderate
NW 65 <sup>th</sup> Street to NW Market Street 45 mph	10b	72	63	No Impact	58	No Impact
	11	60	71 <sup>a</sup>	Potentially significant	58	Moderate
	12	72	69	Potentially significant	62	No Impact
	13	70	61	No Impact	59	No Impact
	14	60	59	Moderate	57	No Impact
	15	67	57	No Impact	57	No Impact
NW Market Street to Ship Canal 50 mph	16	59	55	No Impact	55	No Impact
	17	70	64	No Impact	61	No Impact
	18	63	61	Potentially Significant	58	No Impact

<sup>a</sup> Impacts caused by the removal of existing buildings with the project that shield homes from traffic noise. However, new Green Line station structures could block noise. In addition, space below station platforms is anticipated to be developed or incorporated into the station structure and may block noise.

Source: Modeling and calculations by MFG, Inc.

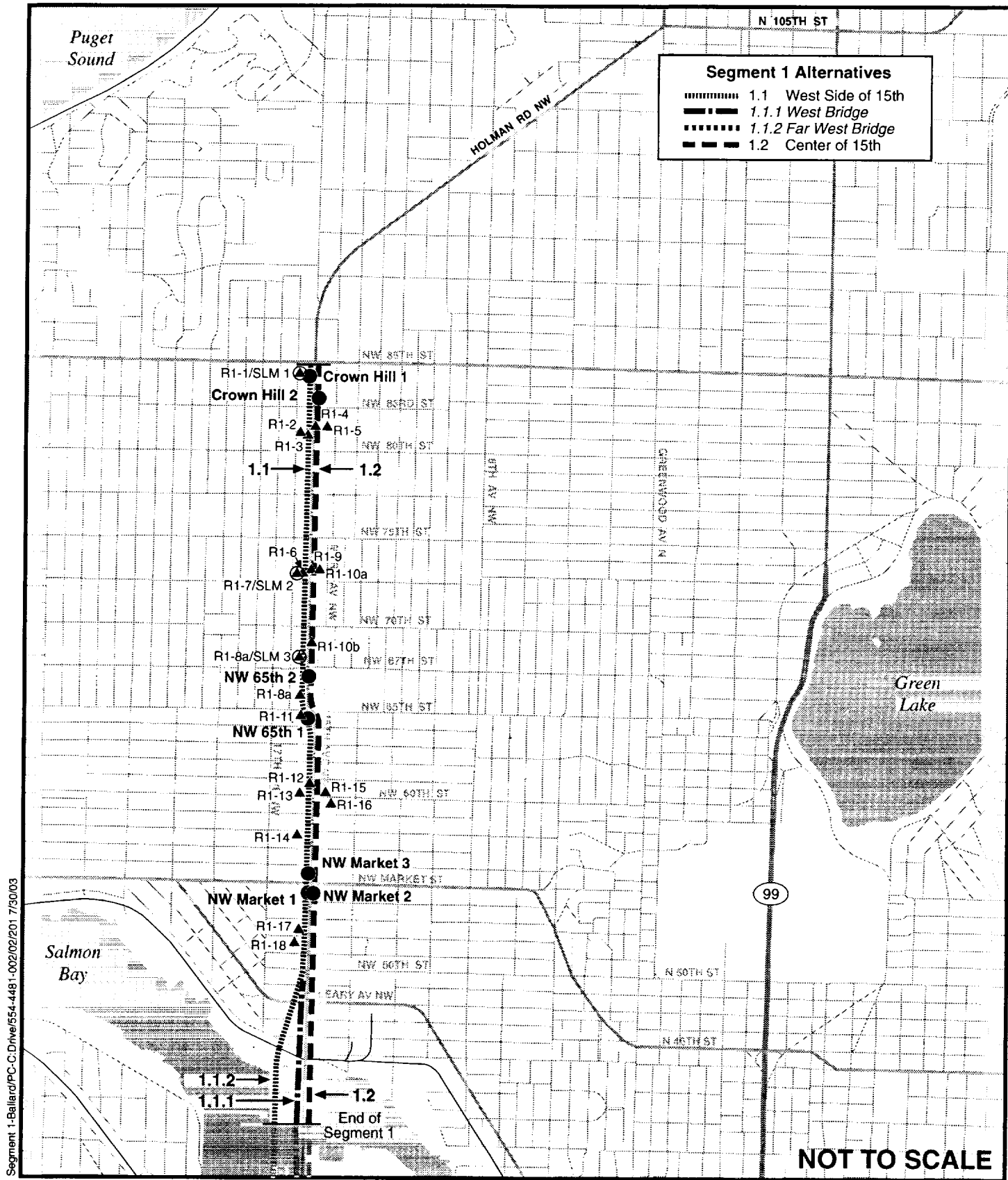
#### Alternative 1.1 - West Side of 15<sup>th</sup> Avenue NW

**NW 85<sup>th</sup> Street to NW 80<sup>th</sup> Street.** Modeling indicates operation of the Green Line on the Alternative 1.1 alignment would not cause noise impacts within the northernmost subsection of the Ballard Segment between NW 85<sup>th</sup> and 80<sup>th</sup> Streets.

**NW 80<sup>th</sup> Street to Ship Canal.** Modeling indicates operation of the Green Line on the Alternative 1.1 alignment would cause noise impacts in the subsection of the Ballard Segment between NW 80<sup>th</sup> and the Ship Canal. FTA noise impact criteria suggest potentially significant noise impacts at residential receivers west of the alignment at all first row receivers west of the road in this section and moderate impact levels of noise at most second row residential receivers west of the road and at second row receivers east of and within 140 feet of the road.

#### Alternative 1.2 - Center of 15<sup>th</sup> Avenue NW

**NW 85<sup>th</sup> Street to NW 80<sup>th</sup> Street.** Modeling indicates operation of the Green Line on the Alternative 1.2 alignment would not cause noise impacts within the northernmost subsection of the Ballard Segment between NW 85<sup>th</sup> and 80<sup>th</sup> Streets.



Segment 1-Ballard/PC-C Drive/554-4481-002/02/201 7/30/03

SEATTLE MONORAIL PROJECT



R1-1/SLM 1 (Receptor and SLM)  
R1-2 (Receptor)

**Figure 4.7-5**  
**Segment 1: Ballard**  
**SLM and Model Receptor Locations**

**NW 80<sup>th</sup> Street to NW Market Street.** TNM modeling indicates Alternative 1.2 of the Green Line would cause moderate noise impacts in the subsection of the Ballard Segment between NW 80<sup>th</sup> and Market Streets. Modeling predicts moderate noise impacts at second row receivers east of and within 140 feet of the road and at second row receivers west of and within 100 feet of the road.

**NW Market Street to Ship Canal.** TNM modeling indicates Alternative 1.2 of the Green Line would not impact residential receivers in the subsection of the Ballard Segment between NW Market Street and the Ship Canal.

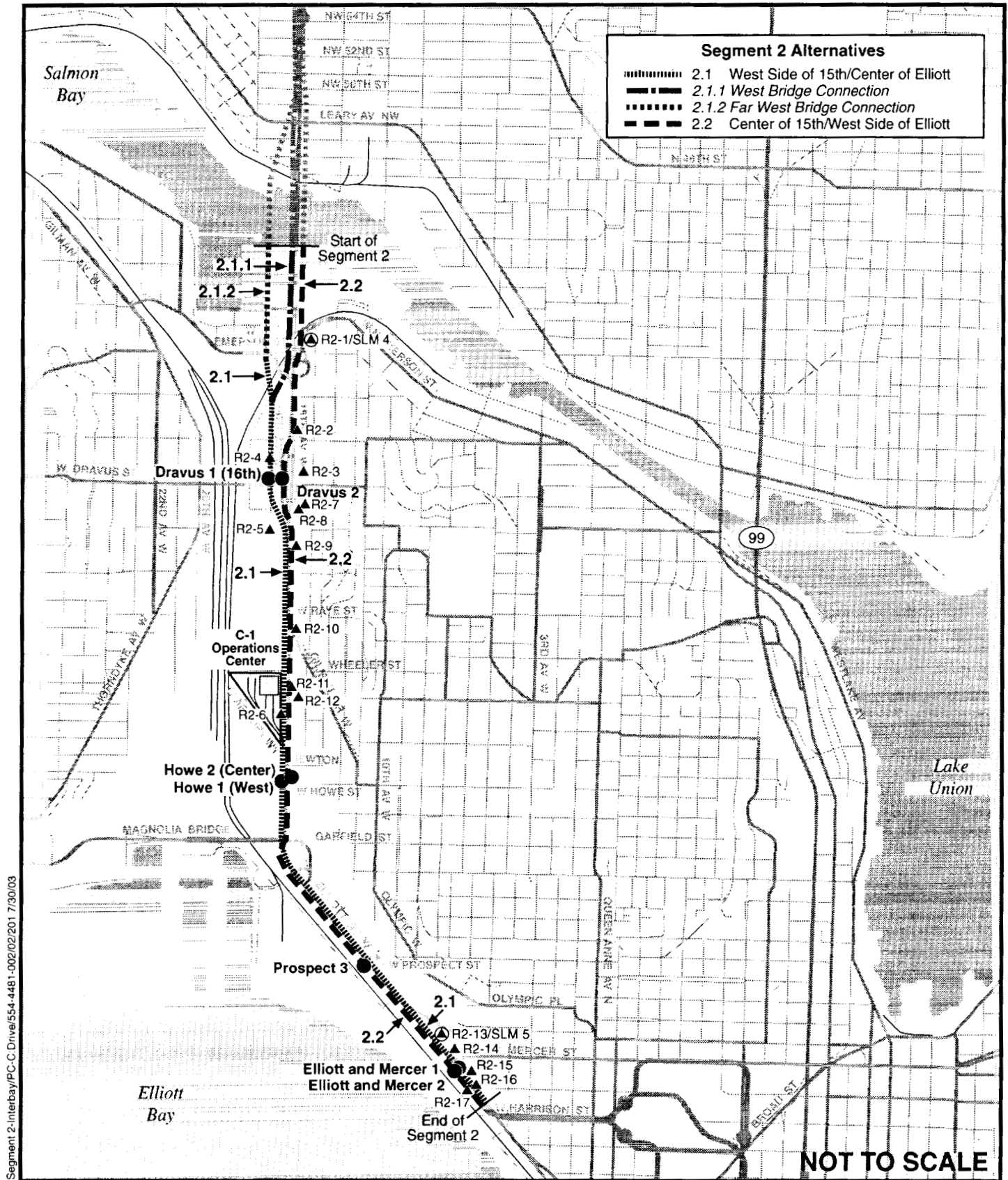
## Segment 2: Interbay Segment

The Interbay Segment of the Green Line was considered as four subsections based on the varying average speeds along the alignment alternatives. The modeling results for the Interbay Segment are summarized in Table 4.7-11 and discussed following the table. The modeling receptors considered in this table are displayed in Figure 4.7-6.



**Table 4.7-11. Impact Analysis Results - The Interbay Segment**

Segment Subdivision	Receptor #	Existing Ldn	Alternative 2.1		Alternative 2.2	
			Monorail Leq/Ldn	Modeled Impact	Monorail Leq/Ldn	Modeled Impact
Ship Canal to W Dravus Street 40 mph	1	70	51	No Impact	55	No Impact
	2	70	49	No Impact	57	No Impact
	3	63	50	No Impact	53	No Impact
	4	62 <sup>(a)</sup>	59 <sup>(a)</sup>	No Impact	53 <sup>(a)</sup>	No Impact
W Dravus Street to W Mercer Place 50 mph	5	62 <sup>(a)</sup>	57 <sup>(a)</sup>	No Impact	54 <sup>(a)</sup>	No Impact
	6	65 <sup>(a)</sup>	70 <sup>(a)</sup>	No Impact	63 <sup>(a)</sup>	No Impact
	7	63	52	No Impact	54	No Impact
	8	67	53	No Impact	55	No Impact
	9	74	62	No Impact	64	No Impact
	10	73	60	No Impact	61	No Impact
	11	74	62	No Impact	64	No Impact
	12	63	56	No Impact	57	No Impact
W Mercer Place to W Mercer Street 35 mph	13	71	52	No Impact	50	No Impact
	14	73	55	No Impact	53	No Impact
W Mercer Street to W Harrison Street 30 mph	15	71	53	No Impact	51	No Impact
	16	76	56	No Impact	53	No Impact
	17	70 <sup>(a)</sup>	54 <sup>(a)</sup>	No Impact	60 <sup>(a)</sup>	No Impact

<sup>a</sup> Level is highest 1-hour Leq instead of Ldn, as is appropriate for non-residential receivers. Source: Modeling and calculations by MFG, Inc.



**Figure 4.7-6**  
**Segment 2: Interbay**  
**SLM and Model Receptor Locations**

R2-1/SLM 4  Receptor and SLM  
 R2-2  Receptor

### Alternative 2.1 – West Side of 15<sup>th</sup>/Center of Elliott

Noise impact modeling indicates the Alternative 2.1 alignment of the Green Line through the Interbay Segment would not cause noise impacts at any of the residential, recreational, or commercial locations considered.

### Alternative 2.2 – Center of 15<sup>th</sup>/West Side of Elliott

Modeling indicates the Alternative 2.2 alignment of the Green Line through the Interbay Segment would not cause noise impacts in the Interbay Segment.

## **Interbay Operations Center Alternative**

The Interbay Segment includes one of two possible locations for an Operations Center. The facility would include maintenance, storage, operations control, and offices. The potential Operations Center location in this segment is on a triangular site between 15<sup>th</sup> Avenue W, W Wheeler Street, and W Armory Way. Green Line trains would access the site via guideways at W Armory Way, connecting to the mainline guideway along 15<sup>th</sup> Avenue W. For the connections to the mainline guideway, switches and crossover tracks would be required.

Noise from the Operations Center would be subject to the limits in the Seattle noise ordinance (see Table 4.7-4), and the residential limits would have to be met at the residential receivers east across 15<sup>th</sup> Avenue W of the potential Operations Center site. Noise control is one of many factors that would be considered in the ultimate design of this facility at this site. Noise occurring within this facility (e.g., light and heavy vehicle maintenance) would be substantially controlled by the structure of the building.

Much of the maintenance activity would likely involve relatively little noise. Louder activities would include such things as use of pneumatic tools and banging on metal that could result in temporary increases in noise in nearby, unshielded locations. Given the north/south alignment of the Green Line, the Operations Center would likely be oriented with its major openings facing north and/or south. There are no residential receivers within 500 feet either directly north or south of this site. The closest residential uses are to the east, across 15<sup>th</sup> Avenue W, and these receivers are subject to high levels of traffic noise from this road.

The closest residence is approximately 250 feet east of the closest portion of the site where the Operations Center could be located. The estimated existing sound level at this residential location is 71 dBA L<sub>dn</sub>. Under FTA criteria, it would take an L<sub>dn</sub> level of 66 dBA from equipment noise to cause a noise impact. At a distance of 250 feet, pneumatic tools or banging on metal would produce noise levels less than 60 dBA, assuming there would not be direct line-of-sight exposure to the noise sources. Assuming such noise occurred all day and night, the resulting L<sub>dn</sub> level at 250 feet (without direct line-of-sight) would be about 64 dBA. Because such maintenance activity would not occur consistently over a 24-hour period, the actual L<sub>dn</sub> from such activity would likely be much lower, and thus would not cause an impact under FTA criteria.

The City of Seattle noise limits are based on the zoning of the noise source and the receiving properties. The proposed Interbay Operations Center site is on property zoned for industrial use, and the closest residences east of 15<sup>th</sup> Avenue W and adjacent to the roadway are in a commercial zone. The Seattle noise limit for industrial sources affecting commercial receivers is 65 dBA day and night, and the estimated sound levels at 250 feet (at locations without direct line-of-sight) of less than 60 dBA. Such levels would comply the City of Seattle noise limits.

Because maintenance operations noise could be effectively controlled, and given the distances to the closest sensitive receivers, noise from the proposed Interbay Operations Center would be expected to both comply with Seattle noise limits and to avoid noise impacts under FTA criteria.

### **Segment 3: Queen Anne/Seattle Center/Belltown Segment**

The Queen Anne/Seattle Center/Belltown Segment of the Green Line was considered as four subsections that included the alternative alignments on all sides of the Seattle Center along with a number of receptor locations to consider Green Line noise on the Center grounds. The modeling receptors considered in this table are displayed in Figure 4.7-7. The results of the modeling for the Queen Anne/Seattle Center/Belltown Segment are displayed in Table 4.7-12. The approximate numbers of residential units affected by project alternatives are summarized in Table 4.7-15 at the end of the discussion of impacts in this section. Potential noise impacts at indoor and outdoor venues at the Seattle Center also were examined as part of this analysis as described later in this section.

#### *Alternative 3.1 - Seattle Center/Republican*

**W Harrison Street to First Avenue N.** Modeling indicates all three Green Line alternative alignments traversing from Elliott Avenue W to First Avenue N could cause potentially significant noise impacts at first row residential locations along the south side of W Harrison Street. Second row residential buildings would not be affected. Alternatives 3.3 and 3.5 would additionally impact residential receivers north of Harrison that would be displaced by Alternative 3.1 and 3.2 alignments.

**Seattle Center Area.** The Alternative 3.1 alignment would not affect any other residential receivers in this segment. This alternative also would not affect outdoor use areas in the Seattle Center either during non-festival times or during large festivals. During quiet times in the Center, the Green Line would be clearly audible at outdoor locations near the Northwest Rooms and on the lawn north of the International Fountain, but Green Line noise would not substantially increase sound levels over the existing acoustic environment. Locations near the International Fountain are at times dominated by sounds from the fountain, including splashing water, recorded music, and at times, screaming children. Close to the fountain, these noises would continue to dominate the acoustic environment. During performances at typical outdoor venues, and especially at locations near the stage (i.e., where people typically sit), sound levels from stage acts are usually much louder than the levels that would be expected from the Green Line. It is therefore unlikely that Green Line noise would interfere with most performances in outdoor venues at the Seattle Center.

Noise modeling also was used to examine the noise implications of the Alternative 3.1 and 3.1.2 alignments on sound levels outside the Center School classrooms on the third and fourth floors of the Seattle Center House. Judging from a visit to this facility, existing sound levels in these classrooms are dominated by HVAC noise when these rooms are otherwise quiet. The interior acoustic environment would be dominated by conversational sounds or music when these rooms are in use as classrooms. When the windows are closed, noise from outside is mostly inaudible except close to the windows; when the windows are open, noise from the roller coaster and other amusement park rides is at times clearly audible. The noise modeling analysis indicated the two alignment alternatives would have little or no effect on exterior sound levels near these classrooms. This means the Green Line also would have little or no effect on interior sound levels in these classrooms.







**Table 4.7-12. Impact Analysis Results - Queen Anne/Seattle Center/Belltown Segment**

Segment Subdivision	Rec #	SLM #/ Location	Existing Leq/Ldn	Alt 3.1		Alt 3.2		Alt 3.3		Alt 3.5	
				MR Leq/ Ldn	Modeled Impact	MR Leq/ Ldn	Modeled Impact	MR Leq/ Ldn	Modeled Impact	MR Leq/ Ldn	Modeled Impact
W Harrison to Queen Anne Avenue N 40 mph  Queen Anne Avenue N to Vine Street 30 mph	1	SLM 6	61	62	Potentially significant	61	Potentially significant	64	Potentially significant	62	Potentially significant
	2		61	53	No Impact	54	No Impact	57	No Impact	58	No Impact
	3		63	60	Potentially significant	58	No Impact	66	Potentially significant	66	Potentially significant
	4		63	receptor displaced				61	Potentially significant	61	Potentially significant
	5	Center Near Northwest Rooms	57 <sup>a</sup>	55 <sup>a</sup>	No Impact	58 <sup>a</sup>	Moderate				
			70 <sup>a</sup>	55 <sup>a</sup>	No Impact	58 <sup>a</sup>	No Impact				
			80 <sup>a</sup>	55 <sup>a</sup>	No Impact	58 <sup>a</sup>	No Impact				
	6	Center Fountain Lawn	55 <sup>a</sup>	52 <sup>a</sup>	No Impact						
			73 <sup>a</sup>	52 <sup>a</sup>	No Impact						
			78 <sup>a</sup>	52 <sup>a</sup>	No Impact						
	7		70			64	No Impact				
	8a	Center House School	60 <sup>a,b</sup>	50 <sup>a,c</sup>	No Impact						
	8b	Off-site School	58 <sup>a</sup>					57 <sup>a</sup>	Moderate	52 <sup>a</sup>	No Impact
	9	Church	58 <sup>a</sup>					57 <sup>a</sup>	Moderate	57 <sup>a</sup>	Moderate
	10	Center Fisher	58 <sup>a</sup>					54 <sup>a</sup>	No Impact	48 <sup>a</sup>	No Impact
			69 <sup>a</sup>					54 <sup>a</sup>	No Impact	48 <sup>a</sup>	No Impact
	11	Center Mural	56 <sup>a</sup>					51 <sup>a</sup>	No Impact		
			80 <sup>a</sup>					51 <sup>a</sup>	No Impact		
Vine Street to Wall Street 40 mph	12		73	59	No Impact	65	No Impact	65	No Impact	59	No Impact
Wall Street to Lenora Street 35 mph	13	SLM 7	73	60	No Impact	60	No Impact	60	No Impact	60	No Impact
	14		73	59	No Impact	59	No Impact	59	No Impact	59	No Impact
	15		73	59	No Impact	66	Potentially significant	65	No Impact	59	No Impact

<sup>a</sup> Level is highest 1-hour Leq instead of Ldn, as is appropriate for non-residential receivers. Cells that are grayed out indicate receptor locations that are too far from the respective alternative alignments to be affected by that alignment, so no tabulation is included.

<sup>b</sup> This estimate of existing levels is from an SLM in a more shielded location that is not subject to the same levels of noise from the existing amusement park (including a roller coaster) that dominates the exterior acoustic environment at the windows on the third and fourth floors of these school rooms

<sup>c</sup> Also represents Alternative 3.1.2.

Source: Modeling and calculations by MFG, Inc.

**Denny Way to Lenora Street.** The Green Line Alternative 3.1 alignment would not impact any residential receivers in these subsections of the Queen Anne/Seattle Center/Belltown Segment.

Alternative 3.2 - Mercer

**W Harrison Street to First Avenue N.** Alternative 3.2 also could cause potentially significant impacts at first row residential locations along the south side of W Harrison Street. Second row residential buildings would not be affected.

**Seattle Center Area.** The Alternative 3.2 alignment could cause moderate noise impacts at outdoor use locations near the Northwest Rooms in the Center during low-use periods when background sound levels are low. During periods of more intense use, as during major festivals, sound levels from performance venues near the Northwest Rooms would be much louder than Green Line noise, so little if any impact would be expected. During quiet times in the Center, the Green Line would be clearly audible at outdoor locations on the lawn north of the International Fountain, but Green Line noise would not substantially increase sound levels over the existing acoustic environment. The Alternative 3.2 alignment would not affect existing residential uses along Mercer Street because Green Line noise would be far overshadowed by existing noise from the high traffic volumes along Mercer.

**Denny Way to Lenora Street.** The Alternative 3.2 alignment could cause potentially significant noise impacts at first row residential receivers along the south and west sides of Fifth Avenue between Bell and Lenora Streets. Such impacts would result from the small addition of noise from the Green Line to the already high existing levels. Projected Green Line sound levels at first row residential receivers north and east of Fifth Avenue are just below the level that would cause an impact under FTA criteria.

Alternative 3.3 - Thomas

**W Harrison Street to First Avenue N.** Alternative 3.3 could also cause potentially significant noise impacts at first row residential locations along the south side of W Harrison Street west of Queen Anne Avenue N and at first row receivers north of W Harrison Street and west of First Avenue N. The slight southward shift in this alignment could cause potentially significant noise impacts at the first row residential receivers south of W Harrison Street between Queen Anne Avenue N and First Avenue N. Second row residential buildings would not be affected.

**Seattle Center Area.** Modeling indicated the Alternative 3.3 alignment would not affect any outdoor use locations in the Seattle Center, but could cause moderate impacts at both the school and the church south of Thomas Street and east of Second Avenue N just outside the Center.

**Denny Way to Lenora Street.** The Alternative 3.3 alignment would not impact any residential receivers in this portion of the Queen Anne/Seattle Center/Belltown Segment.

Alternative 3.5 - Second/Denny

**W Harrison Street to First Avenue N.** The Alternative 3.5 alignment could cause potentially significant noise impacts at first row residential locations along the south side of W Harrison Street west of Queen Anne Avenue N, as well as first row receivers north of W Harrison Street and west of First Avenue N. The slight southward shift in this alignment would cause potentially significant noise impacts at the first row residential receivers south of W Harrison Street between Queen Anne Avenue N and First Avenue N. Second row residential buildings would not be affected.

**Seattle Center Area.** The Alternative 3.5 alignment would not cause impacts at any outdoor use locations in the Seattle Center, but could cause moderate impacts at the Sacred Heart Church south of Thomas Street and east of Second Avenue N just outside the Center.

**Denny Way to Lenora Street.** The Alternative 3.5 alignment would not cause impacts at any residential receivers in this portion of the Queen Anne/Seattle Center/Belltown Segment.

#### **Seattle Center Interior Performance Venue Impact Assessment**

Concern was raised by operators of both indoor and outdoor performance venues at the Seattle Center regarding the potential for noise from the Green Line to affect activities in these venues. The potential for noise impacts at these venues was assessed using sound level measurements of activities in several outdoor venues for comparison with predicted monorail noise at these same venues. Results of this analysis are discussed above in relation to various alternative alignments' potential to affect outdoor venues at the Center.

Additionally, the potential for effects at two indoor venues was assessed using data from several simultaneous interior/exterior measurements with a loud noise source running outside. These measurements were taken at interior spaces in both the Intiman and Leo K. Theaters and outdoors closer to the sound source, while the sound source (a large diesel compressor) was positioned at (or closer than) the approximate location of the Alternative 1 Green Line alignment near the theaters. The sound attenuation provided by the respective buildings was then assessed using measured sound levels inside and outside with and without the diesel compressor running. Comparing noise from the compressor with the noise from the Green Line, it was possible to evaluate the potential for monorail noise to affect interior performance spaces at the Center. Refer to Appendix R, Noise and Vibration Backup Information, for additional information regarding the details of this assessment.

Based on the measurements at the Intiman and Leo K. Theaters, it is clear that noise from the Green Line traveling at an average speed of 30 mph would not be likely to affect interior sound levels at any of the interior performance venues at the Center. As shown in Figure 4.7-8, noise from the Green Line would be less than measured background levels on the stage of the facility, and thus would most likely be inaudible. The lowest line in this chart represents the calculated level of monorail noise based on the expected outdoor level minus the noise reduction provided by the building envelope (based on these measurements). Because the monorail sound levels are less than the background levels measured in this theater when it was completely empty, noise from the monorail would be unlikely to be audible, especially when the theater is filled with people and the background level is much higher. In point of fact, noise from the diesel generator used in these tests was inaudible in the interior space even though the sound raised the background levels slightly during these measurements.

#### **Segment 4: Downtown Segment**

The Downtown Segment of the Green Line was considered as four subsections. Results of the modeling are summarized in Table 4.7-13, and the modeling receptors considered in this table are displayed in Figure 4.7-7. The approximate numbers of residential units affected by project alternatives are summarized in Table 4.7-15 at the end of the discussion of impacts in this section.

##### *Alternative 4.1 - West Side of Second*

**North of Virginia Street.** Modeling indicates none of the Downtown Segment alternatives would impact residential receivers north of Virginia Street.

**Virginia Street to Pike Street.** Modeling indicates that Alternative 4.1 would not impact any receivers in this segment subsection.

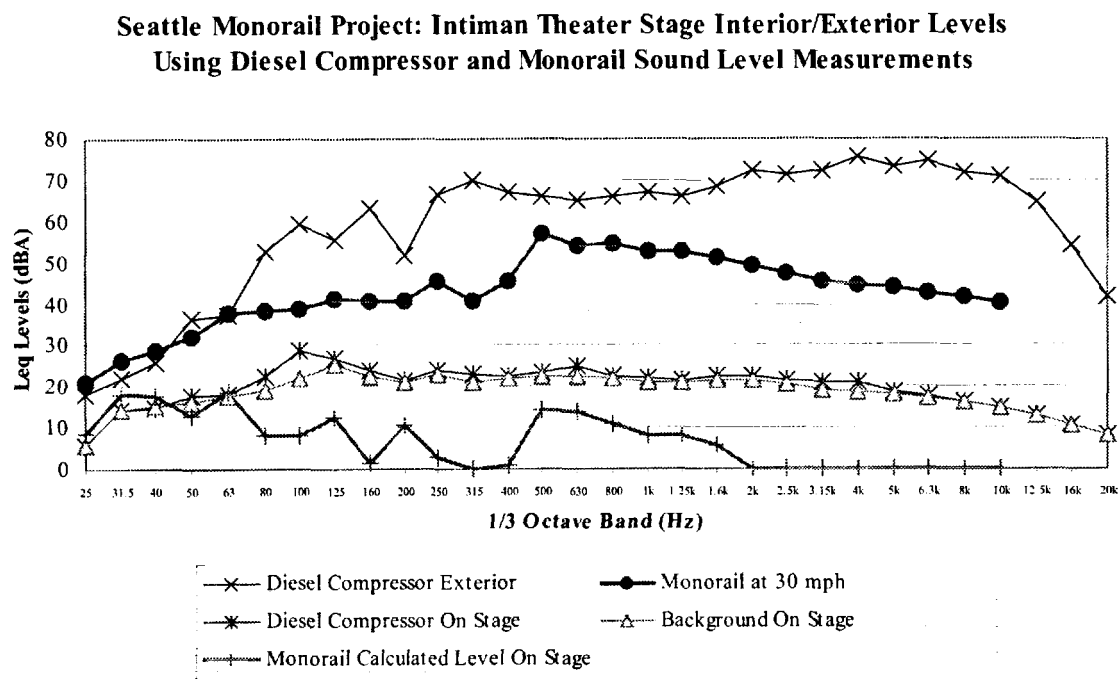
**Pike Street to Marion Street.** Modeling indicates that Alternative 4.1 could cause potentially significant noise impacts at the residential receivers represented by receptor 5, which is the north end of the Newmark building west of Second Avenue between Pike and Union Streets.

**Marion Street to Yesler Way.** Modeling indicates none of the Green Line alternative alignments would impact any receivers in this subsection of the Downtown Segment.

#### *Option 4.1.2 to Alternative 4.1*

Modeling suggests this alternative alignment would have the same noise effects as Alternative 4.1, and would only potentially significantly impact the residential receivers in the north end of the building west of Second Avenue between Pike and Union Streets.

**Figure 4.7-8 Intiman Theater Stage Interior/Exterior Levels Using Diesel Compressor and Monorail Sound Level Measurements**



**Table 4.7-13. Impact Analysis Results - Downtown Segment**

Segment Subdivision	Rec #	Existing Leq/Ldn	Alt 4.1		Alt 4.1.2		Alt 4.2		Alt 4.3	
			MR Leq/Ldn	Modeled Impact	MR Leq/Ldn	Modeled Impact	MR Leq/Ldn	Modeled Impact	MR Leq/Ldn	Modeled Impact
North of Virginia Street 35 mph	1	74	61	No Impact	Same as 4.1		65	No Impact	61	No Impact
Virginia Street to Pike Street 25 mph	2	66	54	No Impact	57		55	No Impact	52	No Impact
	3	66	55	No Impact	Same as 4.1		63	Potentially significant	54	No Impact
	4	66	60	No Impact			54	No Impact	55	No Impact
Pike Street to Marion Street 40 mph	5	66	62	Potentially significant			54	No Impact	58	No Impact
	6	69 <sup>a</sup>	58 <sup>a</sup>	No Impact			66 <sup>a</sup>	Moderate	60 <sup>a</sup>	No Impact
Marion Street to Yesler Way 35 mph	7	69 <sup>a</sup>	62 <sup>a</sup>	No Impact			62 <sup>a</sup>	No Impact	60 <sup>a</sup>	No Impact
	8	69 <sup>a</sup>	58 <sup>a</sup>	No Impact			58 <sup>a</sup>	No Impact	59 <sup>a</sup>	No Impact

<sup>a</sup> Level is highest 1-hour Leq instead of Ldn, as is appropriate for non-residential receivers.

Source: Modeling and calculations by MFG, Inc.

#### Alternative 4.2 - East Side of Second with Crossover

Alternative 4.2 would shift noise impacts from the west to the east of Second Avenue and could potentially cause significant impacts at the residential building at the north end of the block between Pine and Pike Streets in the subsection between Virginia and Pike Streets. This alternative could also cause a moderate noise impact at the outdoor Garden of Remembrance at Benaroya Hall east of Second Avenue between Union and University Streets.

#### Alternative 4.3 - Center of Second

Modeling suggests this alternative alignment would have less potential to cause noise impacts than Alternatives 4.1, 4.1.2, and 4.2, and would not cause impacts at any residential receivers.

### **Segment 5: SODO Segment**

Due to the absence of sensitive noise receivers in the SODO Segment, no noise impacts would be expected. This segment was not examined using noise modeling. Likewise, the possible use of a site in this area for an Operations Center was not specifically considered in the noise analysis. But given the lack of sensitive receivers in the vicinity, it is unlikely this alternative for an Operations Center would result in noise impacts.

### **Segment 6: West Seattle Segment**

The West Seattle Segment of the Green Line was considered as seven subsections. Results of the modeling are summarized in Table 4.7-14, and the modeling receptors considered in this table are displayed in Figure 4.7-9. The approximate numbers of residential units affected by project alternatives are summarized in Table 4.7-15 at the end of the discussion of impacts in this section.

Table 4.7-14. Impact Analysis Results - West Seattle Segment

Segment Subdivision	Rec #	Existing Leq/Ldn	Alt 6.1		Alt 6.1.2		Alt 6.1.4		Alt 6.2	
			MR Leq/ Ldn	Modeled Impact	MR Leq/ Ldn	Modeled Impact	MR Leq/ Ldn	Modeled Impact	MR Leq/ Ldn	Modeled Impact
West Seattle Bridge to 22 <sup>nd</sup> Avenue SW 40 mph	1	76	58	No Impact	62	No Impact	Same as 6.1		55	No Impact
	2	73	55	No Impact	58	No Impact			54	No Impact
22 <sup>nd</sup> Avenue SW to 40 <sup>th</sup> Avenue SW 35 mph	3	79 <sup>a</sup>	66 <sup>a</sup>	Moderate	Same as 6.1				49 <sup>a</sup>	No Impact
	4	64 <sup>a</sup>	62 <sup>a</sup>	Moderate					53 <sup>a</sup>	No Impact
	5	72 <sup>a</sup>	53 <sup>a</sup>	No Impact					64 <sup>a</sup>	No Impact
	6	70	62	No Impact					62	No Impact
	7	65	55	No Impact					55	No Impact
	8	70	57	No Impact			54		46	No Impact
	9	67	61	No Impact			57		46	No Impact
	10	70	65	Potentially significant			59		46	No Impact
	11	67	56	No Impact			Same as 6.1		50	No Impact
	12	70	59	No Impact					50	No Impact
	13	63	62	Potentially significant					53	No Impact
	14	60	56	No Impact					50	No Impact
22 <sup>nd</sup> Avenue SW to 40 <sup>th</sup> Avenue SW 35 mph (continued)	15	70	62	No Impact					62	No Impact
	16	67 <sup>a</sup>							60 <sup>a</sup>	No Impact
	17	61							55	No Impact
	18	67							57	No Impact
	19	72 <sup>a</sup>	57 <sup>a</sup>	No Impact			64 <sup>a</sup>		45 <sup>a</sup>	No Impact
	20	49					Same as 6.1		51	No Impact
40 <sup>th</sup> Avenue SW to SW Hudson Street 20 mph	21	49							55	Moderate
	22	66	56	No Impact					54	No Impact
	23	61	51	No Impact					47	No Impact
	24	66	55	No Impact					59	No Impact
	25	61	50	No Impact					50	No Impact
	26	66	62	Potentially significant					60	No Impact
SW Hudson Street to SW Dawson Street 35 mph	27	66	62	Potentially significant					67	Potentially significant
	28	61	53	No Impact					54	No Impact
SW Dawson Street to SW Raymond Street 50 mph	29	66	68	Potentially significant					66	Potentially significant
	30	63	57	No Impact					59	No Impact
	31	66	62	Potentially significant					63	Potentially significant
	32	61	57	No Impact					58	No Impact
	33	66	68	Potentially significant					73	Potentially significant
				No Impact						No Impact

**Table 4.7-14. Impact Analysis Results - The West Seattle Segment (continued)**

Segment Subdivision	Rec #	Existing Leq/Ldn	Alt 6.1		Alt 6.1.2		Alt 6.1.4		Alt 6.2	
			MR Leq/ Ldn	Modeled Impact	MR Leq/ Ldn	Modeled Impact	MR Leq/ Ldn	Modeled Impact	MR Leq/ Ldn	Modeled Impact
SW Raymond Street to SW Graham Street 40 mph	34	66	63	Potentially significant					65	Potentially significant
	35	66	64	Potentially significant					81	Potentially significant
SW Graham Street to south of SW Holly Street 25 mph	36	66	59	No Impact					66	No Impact
	37	68							58	No Impact
	38	66	58	No Impact					69	Potentially significant
	39	68	55	No Impact					62	No Impact
	40	68							57	No Impact

<sup>a</sup> Level is highest 1-hour Leq instead of Ldn, as is appropriate for non-residential receivers. Cells that are grayed out indicate receptor locations that are too far from the respective alternative alignments to be affected by that alignment, so no tabulation is included.

Source: Modeling and calculations by MFG, Inc.

#### Alternative 6.1 - West Seattle Bridge

**West Seattle Bridge to 22<sup>nd</sup> Avenue SW.** Noise modeling indicates none of the Green Line alternative alignments would cause impacts at any receivers in this subsection of this segment.

**22<sup>nd</sup> Avenue SW to 40<sup>th</sup> Avenue SW.** Modeling indicates the Alternative 6.1 alignment could cause moderate impacts at two non-residential receptors and potentially significant impacts at two residential receptors in this subsection of the West Seattle Segment. Moderately affected receptor 6-3 represents several commercial buildings west of Delridge Way SW, and receptor 6-4 represents the southern portion of an open space south of SW Andover Street. Receptor 6-10 represents the several residential receivers north and west of Fauntleroy Way SW at SW Oregon Street where predicted Green Line noise levels would reach the impact threshold. Receptor 6-13 represents the numerous residential receivers along the south side of SW Yancy Street that could be significantly affected by the Green Line noise. Predicted future Green Line noise levels would remain below the impact threshold at all other receptors in this subsection of the West Seattle Segment.

**40<sup>th</sup> Avenue SW to SW Hudson Street.** Modeling indicates none of the residential receptor locations in this subsection of the West Seattle Segment would be affected by noise from the Alternative 6.1 alignment of the Green Line.

**SW Hudson Street to SW Dawson Street.** Modeling indicates the Green Line could potentially cause significant impacts to first row residential receivers on both the east and west sides of California Avenue SW between SW Hudson and Dawson Streets. Predicted sound levels at second row receivers are less than impact levels.

**SW Dawson Street to SW Raymond Street.** Modeling indicates the Green Line could potentially cause significant impacts to first row residential receivers on both the east and west sides of California Avenue SW between SW Dawson and Raymond Streets.





**SW Raymond Street to SW Graham Street.** Modeling indicates the Green Line could cause potentially significant impacts at first row residential receivers on both the east and west sides of California Avenue SW between SW Raymond and Graham Streets.

**SW Graham to South of SW Holly Street.** Modeling indicates the Green Line would not cause impacts to any receivers in this subsection of the West Seattle Segment.

*Option 6.1.2 to Alternative 6.1*

This optional alignment from the West Seattle Bridge to 22<sup>nd</sup> Avenue SW would slightly increase sound levels near this subsection, but would not cause noise impacts due to the change. In all other respects, this option would result in the same sound levels as Alternative 6.1.

*Option 6.1.4 to Alternative 6.1*

This optional alignment in the 22<sup>nd</sup> Avenue to 40<sup>th</sup> Avenue SW area would slightly increase sound levels near this subsection, but would not cause noise impacts due to the change. In all other respects, this option would result in the same sound levels as Alternative 6.1.

*Alternative 6.2 – New Bridge*

**West Seattle Bridge to 22<sup>nd</sup> Avenue SW.** Noise modeling indicates none of the Green Line alternative alignments would affect any receivers in this subsection of this segment.

**22<sup>nd</sup> Avenue SW to 40<sup>th</sup> Avenue SW.** Modeling indicates the Alternative 6.2 alignment would not cause noise impacts at any receptor locations in this subsection of the West Seattle Segment.

**40<sup>th</sup> Avenue SW to SW Hudson Street.** Modeling indicates the Alternative 6.2 alignment of the Green Line would cause moderate impacts at Receptor 6-21, representing the residential receivers east of 44<sup>th</sup> Avenue SW and north of SW Edmunds Street. Predicted future Green Line noise levels would remain below the impact threshold at all other receptors in this subsection of the West Seattle Segment.

**SW Hudson Street to SW Dawson Street.** Modeling indicates the Green Line could cause potentially significant impacts at first row residential receivers on the east side of California Avenue SW between SW Hudson and Dawson Streets. Predicted sound levels west of the road and at second row receivers would be less than impact levels.

**SW Dawson Street to SW Raymond Street.** Modeling indicates the Green Line could potentially cause significant impacts to first row residential receivers east of the road (Receptor 6-33) and cause impacts to first row receivers west of the road and second row receivers east of California Avenue SW between SW Dawson and Raymond Streets.

**SW Raymond Street to south of SW Graham Street.** Modeling indicates the Green Line could potentially cause significant impacts to first row residential receivers on the east side of California Avenue SW between SW Raymond Street and about one-half block south of SW Graham Street.

**SW Graham Street to south of SW Holly Street.** Modeling indicates the Green Line would not affect any receivers in this subsection of the West Seattle Segment.

Table 4.7-15 provides an estimate of the numbers of residential units that could be potentially affected by noise related to the proposed Green Line project.

**Table 4.7-15. Potentially Affected Residential Receivers by Project Segment and Alternative**

<b>Green Line Segment</b>	<b>Green Line Alternative</b>	<b>Residential Receiver Location</b>	<b>Impact Type</b>	<b>Approximate # of Affected Residences</b>
<b>Ballard</b> NW 80 <sup>th</sup> Street to NW 51 <sup>st</sup> Street	1.1	First row west of road	Potentially Significant	110
		Second row west of road - with partial shielding from 15 <sup>th</sup>	Moderate	80
		Second row east of, and within 140' of road	Moderate	20
	1.2	Second row east of, and within 140' of road	Moderate	20
		Second row west of road within 100' of road	Moderate	12
<b>Queen Anne/Seattle Center/Belltown</b>	3.1	W Harrison Street to Queen Anne First row south of Harrison	Potentially Significant	16
	3.2	W Harrison Street to Queen Anne First row south of Harrison	Potentially Significant	8
		Bell Street to Lenora Street	Potentially Significant	26
	3.3 and 3.5	W Harrison Street to Queen Anne First row south of Harrison	Potentially Significant	16
		W Harrison Street to Queen Anne First row north of Harrison	Potentially Significant	18
<b>Downtown</b>	4.1.1 and 4.1.2	Pike Street to Marion Street First row west of Second Avenue	Potentially Significant	30
	4.2	Pine Street to Pike Street First row east of Second Avenue	Potentially Significant	12
<b>West Seattle</b>	6.1	Yancy Street Area First row receivers	Potentially Significant	15
		Avalon Area First row receivers	Potentially Significant	2
		Hudson to Graham First row receivers	Potentially Significant	278
	6.2	40 <sup>th</sup> to Hudson First row receivers	Moderate	12
		Hudson to Holly First row receivers	Potentially Significant	217

Source: Modeling and calculations by MFG, Inc.

#### **4.7.2.3 Vibration Impact Assessment from Green Line Operations**

##### **Segment 1: Ballard Segment**

Potentially sensitive land uses along the Ballard Segment are Residential (vibration impact limit 72 VdB re 1 micro inch/sec) and Institutional (vibration impact limit 75 VdB re 1 micro inch/sec), with no High Sensitivity or Special Buildings along either alignment Alternative 1.1 or 1.2. This section focuses the vibration impact analysis discussion on land use types that are sensitive to vibration as described above in Section 4.7.1.4. Refer to Section 4.3, Land Use and Neighborhoods, for a more complete description of land use impacts to all land use types.

### Alternative 1.1 - West Side of 15<sup>th</sup>

The distance from the centerline of the Green Line alignment Alternative 1.1 to the closest residential receiver property is 12 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB re 1 micro inch/sec limit for this land use.

The closest Historic Building is B-114, Historic Apartment Building, 1505 NW 60<sup>th</sup> Street, located 25 feet from the alignment Alternative 1.1. Corresponding vibration levels at the Apartment Building from Green Line operations are below 61.4 VdB re 1 micro inch/sec. Therefore, the predicted future vibration levels are below the 72 VdB re 1 micro inch/sec limit for this land use and well below the limits for architectural damages to extremely fragile historic buildings.

Support columns for the Green Line west bridge Alternative 1.1.1 and far west bridge Alternative 1.1.2 could be placed next to existing offices, with vibration levels at the column base of 74.0 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 75.0 VdB re 1 micro inch/sec limit for Institutional land uses.

### Alternative 1.2 - Center of 15<sup>th</sup> Avenue

The distance from the centerline of the Green Line alignment Alternative 1.2 to the closest residential receiver property is 50 feet, corresponding to a vibration level of 53.4 VdB re 1 micro inch/sec at the property line. The predicted future vibration levels are below the limits for residential land uses.

Building B-114, Historic Apartment Building, 1505 NW 60<sup>th</sup> Street, is located 50 feet from alignment Alternative 1.2. Corresponding vibration levels at the Apartment Building from monorail operation are 53.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the limits for this land use and well below the limits for architectural damages to extremely fragile historic buildings.

Support columns for the Green Line east bridge Alternative 1.2 could be placed next to existing commercial buildings, with vibration levels at the column base of 74.0 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 75.0 VdB re 1 micro inch/sec limit for Institutional land use.

The closest Historic Building is B-131, Mike's Chili Parlor, 1447 NW Ballard Way, located 25 feet from alignment Alternative 1.2. Corresponding vibration levels at Mike's Chili Parlor from Green Line operation are below 61.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 75 VdB re 1 micro inch/sec threshold for this land use and well below the 95 VdB re 1 micro inch/sec threshold for architectural damages to extremely fragile historic buildings.

### Ballard Segment Summary

Since all sensitive land uses are below the maximum vibration threshold, no vibration impacts would be expected with Alternative 1.1 or 1.2. Due to the longer average distance between the Green Line columns and adjacent property, Alternative 1.2 would generate lower overall vibration levels than Alternative 1.1.

### **Segment 2: Interbay Segment**

Potentially sensitive land uses along the Interbay Segment are Residential (vibration impact limit 72 VdB re 1 micro inch/sec) and Institutional (vibration impact limit 75 VdB re 1 micro inch/sec), with two High

Sensitivity land uses (vibration impact limit 65 VdB re 1 micro inch/sec) along either alignment Alternative 2.1 or 2.2:

- Friedman & Bruya, Inc., Environmental Chemists, at 3012 16<sup>th</sup> Avenue W.
- Amgen Campus at 1555 W Galer Street.

#### Alternative 2.1 - West Side of 15<sup>th</sup>/Center of Elliott

The minimum distance from the centerline of Alternative 2.1 to the closest receiver property is 10 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72.0 VdB limit for Residential and 75.0 VdB limit for Institutional land uses.

Between the Dravus 1 (16<sup>th</sup>) station alternative and the alignment transition to the west side of 15<sup>th</sup> Avenue W, the Green Line alignment passes through some residential land uses. Support columns could be placed next to existing structures, with vibration levels at the column base of 74.0 VdB re 1 micro inch/sec. Locating Green Line columns at least 10 feet away from residential land use would reduce vibration levels below the 72 VdB threshold.

The Friedman & Bruya, Inc. site located at 3012 16<sup>th</sup> Avenue W is a High Sensitivity land use for vibration. The Green Line alignment Alternative 2.1 is located over the northeast corner of the property approximately 20 feet from the building. This would result in vibration levels of 61.4 VdB re 1 micro inch/sec, which is below the 65 VdB re 1 micro inch/sec maximum vibration level for this sensitive receiver.

The Amgen Campus located at 1555 W Galer Street (Pier 88) is also a High Sensitivity land use. The Green Line alignment Alternative 2.1 along the center of Elliott Avenue W is more than 250 feet away from the closest building structure, with vibration levels below 45 VdB re 1 micro inch/sec. This is substantially lower than the 65 VdB threshold for this type of use.

The closest Historic Building is I-74, Ace Tank, 1123c Elliott Avenue W, located 50 feet from alignment Alternative 2.1. Corresponding vibration levels at Ace Tank from Green Line operations are 53.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 75 VdB threshold for this land use and well below the 95 VdB threshold for architectural damage to extremely fragile historic buildings.

#### Alternative 2.1.1 - West Bridge Connection

Support columns for alignment Alternative 2.1.1 could be placed next to existing structures, with vibration levels at the column base of 74.0 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 75 VdB threshold for Institutional land uses.

#### Alternative 2.1.2 - Far West Bridge Connection

Support columns for alignment Alternative 2.1.2 could be placed next to existing structures, with vibration levels at the column base of 74.0 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 75 VdB threshold for Institutional land uses.

#### Alternative 2.2 - Center of 15<sup>th</sup>/West Side of Elliott

The predicted future vibration levels are below the limits for Residential (72 VdB re 1 micro inch/sec) and Institutional land uses (75 VdB re 1 micro inch/sec). The minimum distance from the centerline of

alignment Alternative 2.2 to the closest receiver property is 10 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line.

The east bridge connection associated with Alternative 2.2 is more than 100 feet away from the closest residential land use, corresponding to a vibration level of 46.4 VdB re 1 micro inch/sec. This is well below the maximum vibration level of 72 VdB re 1 micro inch/sec for residential land use.

Between the Dravus 2 (15<sup>th</sup>) station alternative and the alignment transition to the center of 15<sup>th</sup> Avenue W, the distance to the closest structure is 50 feet, corresponding to a vibration level of 53.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the limits for Residential (72 VdB) and Institutional (75 VdB) land uses.

The Friedman & Bruya, Inc. site located at 3012 16<sup>th</sup> Avenue W is a High Sensitivity land use. The Green Line alignment Alternative 2.2 is approximately 100 feet away from the building, corresponding to a vibration level of 46.4 VdB re 1 micro inch/sec. This is well below the maximum vibration level of 65 VdB re 1 micro inch/sec for this sensitive receiver.

The Amgen Campus located at 1555 W Galer Street (Pier 88) is also a High Sensitivity land use. The Green Line alignment Alternative 2.2 along the west side of Elliott Avenue W is more than 200 feet away from the closest building structure, with vibration levels well below 45 VdB re 1 micro inch/sec. This is substantially lower than the 65 VdB threshold for this land use type.

The closest Historic Building is I-74, Ace Tank, 1123c Elliott Avenue W, located 25 feet from alignment Alternative 2.2. Corresponding vibration levels at Ace Tank from Green Line operations are below 61.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 75 VdB threshold for this land use and well below the 95 VdB threshold for architectural damages to extremely fragile historic buildings.

#### Interbay Segment Summary

Since all sensitive land uses are below the maximum vibration thresholds, no vibration impacts would be expected with Alternative 2.1 or 2.2. Due to the longer average distance between Green Line columns and adjacent properties (including the Friedman & Bruya, Inc. sensitive receiver), Alternative 2.2 has a lower overall vibration impact than Alternative 2.1.

### **Segment 3: Queen Anne/Seattle Center/Belltown Segment**

Potentially sensitive land uses along the Queen Anne/Seattle Center/Belltown Segment are Residential (vibration impact limit 72 VdB re 1 micro inch/sec) and Institutional (vibration impact limit 75 VdB re 1 micro inch/sec) with three Special Buildings (vibration impact limit 65 VdB re 1 micro inch/sec for Concert Halls, and 72 VdB re 1 micro inch/sec for Theaters) along Green Line alignment Alternatives 3.1, 3.2, 3.3, or 3.5.

#### Alternative 3.1 - Seattle Center/Republican

The minimum distance from the centerline Green Line alignment Alternative 3.1 to the closest receiver property is 10 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the limits for Residential (72 VdB) and Institutional (75 VdB) land uses.

On W Harrison Street between Elliott Avenue W and First Avenue N, alignment Alternative 3.1 is located adjacent to residential uses with vibration levels at the column base of 74.0 VdB re 1 micro inch/sec. Locating columns 10 or more feet away from these residential structures would reduce vibration levels to 59.8 VdB, well below the threshold of 72 VdB.

Between Broad Street and Fifth Avenue, alignment Alternative 3.1 would be adjacent to structures with institutional land uses. With the predicted vibration levels at the base of the support columns being 74.0 VdB re 1 micro inch/sec, vibration levels are below the limits for institutional land uses.

The Bagley Wright Theater and Intiman Theater are both located 140 feet from alignment Alternative 3.1, corresponding to vibration levels below 46.4 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the maximum 72 VdB vibration levels for theaters. Therefore, no vibration impacts to the Bagley Wright Theater and Intiman Theater are expected.

The Marion Oliver McCaw Hall is located more than 250 feet away from alignment Alternative 3.1, corresponding to vibration levels below 45.0 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the maximum 72 VdB vibration levels for concert halls. Therefore, no vibration impact to the Marion Oliver McCaw Hall is expected.

The closest Historic Building is SC-15, Center House at Seattle Center, located 15 feet from alignment Alternative 3.1. Corresponding vibration levels at the Historic Building from monorail operation are below 65.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the limits for this land use and well below the 95 VdB limit for architectural damages to extremely fragile historic buildings.

#### Alternative 3.1.1 - Through EMP

With the Green Line going through the EMP, the vibration levels at the outer edge of the building approximately 10 feet away from the base of the columns are predicted to be 65.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 72 VdB limit for theaters. Therefore, no vibration impact to the EMP is expected.

No increase of the vibration levels inside the EMP would be expected since the existing monorail currently goes through EMP on a similar alignment. With the new Green Line train and guideway design, the vibration impact to the EMP would be lower than current levels.

#### Alternative 3.1.2 - Around EMP

The minimum distance from the centerline of Green Line alignment Alternative 3.1.2 to the closest receiver property is 10 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB threshold for theaters.

#### Alternative 3.2 - Mercer

The minimum distance from the centerline of Green Line alignment Alternative 3.2 to the closest receiver property is 10 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB threshold for Residential and 75 VdB threshold for Institutional land uses.

On W Harrison Street between Elliott Avenue W and First Avenue N, alignment Alternative 3.2 is located adjacent to residential uses with vibration levels at the column base of 74.0 VdB re 1 micro inch/sec.

Locating columns 10 or more feet away from these residential structures would reduce vibration levels to 59.8 VdB, well below the 72 VdB threshold.

The Bagley Wright Theater is located 30 feet from alignment Alternative 3.2, corresponding to vibration levels below 58.4 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the 72 VdB threshold for theaters. Therefore, no vibration impact to the Bagley Wright Theater is expected.

The Intiman Theater is located 60 feet from alignment Alternative 3.2, corresponding to vibration levels below 53.4 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the 72 VdB threshold for theaters. Therefore, no vibration impact to the Intiman Theater is expected.

The Marion Oliver McCaw Hall is located more than 60 feet from alignment Alternative 3.2, corresponding to vibration levels below 53.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the limits for concert halls. Therefore, no vibration impact to the Marion Oliver McCaw Hall is expected.

The closest Historic Building is SC-20, Auditorium Apartments, 605 Fifth Avenue N, located 20 feet from the alignment Alternative 3.2. Corresponding vibration levels at the Historic Building from monorail operation are 61.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 72 VdB threshold for this land use and well below the 95 VdB threshold for architectural damages to extremely fragile historic buildings.

#### Alternative 3.3 - Thomas

The minimum distance from the centerline of the Green Line alignment Alternative 3.3 to the closest receiver property is 10 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB threshold for Residential and 75 VdB threshold for Institutional land uses.

On W Harrison Street between Elliott Avenue W and First Avenue N, alignment Alternative 3.3 is located adjacent to residential uses with vibration levels at the column base of 74.0 VdB re 1 micro inch/sec. Locating columns 10 or more feet away from these residential structures would reduce vibration levels to below the 72.0 VdB threshold for this use.

No vibration impact to Bagley Wright Theater, Intiman Theater, or Marion Oliver McCaw Hall would be expected with alignment Alternative 3.3.

The closest Historic Building is SC-7, 7 Queen Anne Avenue N, located 25 feet from the alignment Alternative 3.3. Corresponding vibration levels at the Historic Building from monorail operation are below 61.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 72 VdB threshold for this land use and well below the 95 VdB threshold for architectural damages to extremely fragile historic buildings.

#### Alternative 3.5 - Second/Denny

The minimum distance from the centerline of the Green Line alignment Alternative 3.5 to the closest receiver property is 10 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB threshold for Residential and 75 VdB threshold for Institutional land uses.

On W Harrison Street between Elliott Avenue W and First Avenue N, alignment Alternative 3.5 is located adjacent to residential uses, with vibration levels at the column base of 74.0 VdB re 1 micro inch/sec. Locating columns 10 or more feet away from these residential structures would reduce vibration levels to below the 72.0 VdB threshold for this use.

The Seattle Children's Theater is located 50 feet from alignment Alternative 3.5, corresponding to vibration levels of 53.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 72 VdB threshold for theaters. Therefore, no vibration impact to the Seattle Children's Theater is expected.

Fisher Pavilion is located 50 feet from alignment Alternative 3.5, corresponding to vibration levels below 53.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 65 VdB threshold for recording studios. Therefore, no vibration impact to Fisher Pavilion is expected.

No vibration impact to Bagley Wright Theater, Intiman Theater, or Marion Oliver McCaw Hall would be expected with Alternative 3.5.

The closest Historic Building is SC-7, 7 Queen Anne Avenue N, located 25 feet from alignment Alternative 3.5. Corresponding vibration levels at the Historic Building from monorail operation are below 61.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 72 VdB threshold for this land use and well below the 95 VdB threshold for architectural damage to extremely fragile historic buildings.

#### Queen Anne/Seattle Center/Belltown Segment Summary

Since all sensitive land uses are below the maximum vibration thresholds, no vibration impacts would be expected with Alternatives 3.1, 3.2, 3.3, or 3.5. Due to the longer distance between Green Line columns and sensitive receivers in this segment, Alternatives 3.3 and 3.5 would generate the lowest vibration levels of all alternatives. The highest overall vibration level would occur with Alternative 3.2 due to its close proximity to Seattle Center theaters, although this alternative would not result in vibration impacts.

#### **Segment 4: Downtown Segment**

Potentially sensitive land uses along the Downtown Segment are Residential (vibration impact limit 72 VdB re 1 micro inch/sec) and Institutional (vibration impact limit 75 VdB re 1 micro inch/sec) with three Special Buildings (vibration impact limit 65 VdB re 1 micro inch/sec for Concert Halls) along Green Line alignment Alternatives 4.1, 4.2, and 4.3.

#### Alternative 4.1 - West Side of Second

Along Second Avenue, alignment Alternative 4.1 would be adjacent to existing structures where residential land uses exist. The minimum distance from the centerline of Alternative 4.1 to the closest receiver property is 10 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB threshold for Residential and 75 VdB threshold Institutional land uses. There is no difference in impacts for alignment Options 4.1.1 and 4.1.2.

Benaroya Hall is located 60 feet from alignment Alternative 4.1, corresponding to vibration levels below 53.4 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the maximum 65 VdB vibration levels for concert halls. Therefore, no vibration impact to Benaroya Hall is expected.



The Moore Theater is located 100 feet from alignment Alternative 4.1, corresponding to vibration levels of 46.4 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the maximum 72 VdB vibration threshold for theaters. Therefore, no vibration impact to the Moore Theater is expected.

Seattle Art Museum is located 20 feet from the alignment Alternative 4.1, corresponding to vibration levels of 61.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the maximum 72 VdB vibration threshold for auditoriums. Therefore, no vibration impact to the Seattle Art Museum is expected.

The closest Historic Building is D-34, Times Square Building, 414 Olive Way, located 15 feet from alignment Alternative 4.1. Corresponding vibration levels at this Historic Building from Green Line operations are below 65.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 72 VdB threshold for this land use and well below the 95 VdB threshold for architectural damage to extremely fragile historic buildings.

The closest Areaways are 407, 406, 601, 1003, 1004, 1005, and 6001, all located within 10 feet of the alignment Alternative 4.1. Corresponding vibration levels at the Areaways from Green Line operations are 65.4 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the 95 VdB threshold for architectural damage to extremely fragile historic buildings.

#### Alternative 4.2 - East Side of Second with Crossover

The minimum distance from the centerline of alignment Alternative 4.2 to the closest receiver property is 15 feet, corresponding to vibration levels of 63.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB threshold for Residential and 75 VdB threshold for Institutional land uses.

Benaroya Hall is located 15 feet from alignment Alternative 4.2, corresponding to a vibration level of 63.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 65 VdB vibration threshold for concert halls. Therefore, no vibration impact to Benaroya Hall is expected.

The Moore Theater is located more than 100 feet from alignment Alternative 4.2, corresponding to vibration levels below 46.4 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the maximum 65 VdB vibration threshold for theaters. Therefore, no vibration impact to the Moore Theater is expected.

Seattle Art Museum is located 50 feet from alignment Alternative 4.2, corresponding to vibration levels of 53.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 72 VdB maximum vibration threshold for auditoriums. Therefore, no vibration impact to the Seattle Art Museum is expected.

The closest Historic Building is D-34, Times Square Building, 414 Olive Way, located 15 feet from the alignment Alternative 4.2. Corresponding vibration levels at this Historic Building from Green Line operations are below 65.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 72 VdB threshold for this land use and well below the limits for architectural damages to extremely fragile historic buildings.

The closest Areaways are 407, 406, 601, 1003, 1004, 1005, and 6001, all located within 10 feet of alignment Alternative 4.2. Corresponding vibration levels at the Areaways from Green Line operations are 65.4 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the 95 VdB threshold for architectural damages to extremely fragile historic buildings.

#### Alternative 4.3 - Center of Second

The minimum distance from the centerline of alignment Alternative 4.3 to the closest receiver property is 40 feet, corresponding to vibration levels of 55.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB threshold for Residential and 75 VdB threshold for Institutional land uses.

Benaroya Hall is located 40 feet from alignment Alternative 4.3, corresponding to a vibration level of 55.4 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the 65 VdB threshold for concert halls.

The Moore Theater is located more than 100 feet from alignment Alternative 4.3, corresponding to vibration levels below 46.4 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the maximum 72 VdB vibration levels for theaters. Therefore, no vibration impact to the Moore Theater is expected.

Seattle Art Museum is located 30 feet from alignment Alternative 4.2, corresponding to vibration levels of 58.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the maximum 72 VdB vibration threshold for auditoriums. Therefore, no vibration impact to the Seattle Art Museum is expected.

The closest Historic Building is D-126, King Street Station, 301 S Jackson Street, located 30 feet from alignment Alternative 4.3. Corresponding vibration levels at the Historic Building from monorail operation are 58.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 75 VdB threshold for this land use and well below the 95 VdB threshold for architectural damages to extremely fragile historic buildings.

The closest Areaways are 407, 406, 601, 1003, 1004, 1005, and 6001, all located within 10 feet of alignment Alternative 4.3. Corresponding vibration levels at the Areaways from monorail operation are 65.4 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the 95 VdB threshold for architectural damages to extremely fragile historic buildings.

#### Downtown Segment Summary

Since all sensitive land uses are below the maximum vibration threshold, no vibration impacts would be expected with Alternatives 4.1, 4.2, or 4.3.

#### **Segment 5: SODO Segment**

Potentially sensitive land uses along the SODO Segment are mostly Institutional (vibration impact limit 75 VdB re 1 micro inch/sec) with some Residential (vibration impact limit 72 VdB re 1 micro inch/sec). The Pioneer Square Historic District, including King Street Station, is located at the north end of this segment.

#### Alternative 5.1 - East Side of Third/Utah

The minimum distance from the centerline of alignment Alternative 5.1 to the closest receiver property is 10 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the limits for Residential and Institutional land uses. There is no difference in vibration impact for alignment Options 5.1.1 and 5.1.2.

The closest Historic Building is S-58, Markey Machinery Co., 79 S Horton Street, located 40 feet from alignment Alternative 5.1. Corresponding vibration levels at the Historic Building from Green Line operations are 55.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 75 VdB threshold for this land use and well below the 95 VdB threshold for architectural damage to extremely fragile historic buildings.

#### Alternative 5.2 - West Side of Third/Utah

The minimum distance from the centerline of alignment Alternative 5.2 to the closest receiver property is 40 feet, corresponding to vibration levels of 55.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB threshold for Residential and 75 VdB threshold for Institutional land uses.

The closest Historic Building is S-61, Rainier Cold Storage Building, on the southeast corner of S Horton Street and Colorado Avenue S, located 40 feet from alignment Alternative 5.2. Corresponding vibration levels at the Historic Building from Green Line operations are 55.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 72 VdB threshold for this land use and well below the 95 VdB threshold for architectural damages to extremely fragile historic buildings.

#### SODO Segment Summary

Since all sensitive land uses are below the maximum vibration threshold, no vibration impacts would be expected with Alternatives 5.1 and 5.2.

#### **Segment 6: West Seattle Segment**

Land uses along the West Seattle Segment are Residential (vibration impact limit 72 VdB re 1 micro inch/sec) and Institutional (vibration impact limit 75 VdB re 1 micro inch/sec) with no High Sensitivity or Special Buildings along the alignments.

#### Alternative 6.1 - West Seattle Bridge

The minimum distance from the centerline of alignment Alternative 6.1 to the closest receiver property is 10 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB threshold for Residential and 72 VdB threshold for Institutional land uses.

The Arts West Theater is located more than 200 feet from the Alternative Alignment 6.1, corresponding to vibration levels below 46.4 VdB re 1 micro inch/sec. The predicted future vibration levels are well below the maximum 72 VdB vibration threshold for theaters. Therefore, no vibration impact to the Arts West Theater is expected.

Along California Avenue SW, the minimum distance from the centerline of alignment Alternative 6.1 to the closest receiver property is 30 feet, corresponding to vibration levels of 58.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB threshold for residential and 75 VdB threshold for institutional land uses.

The closest Historic Building is WS-154, Residence, 5956-5958 California Avenue SW, located 40 feet from alignment Alternative 6.1. The corresponding vibration level at this Historic Building from Green Line operations is 55.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 72

VdB threshold for this land use and well below the 95 VdB threshold for architectural damage to extremely fragile historic buildings.

#### Alternative 6.2 - New Bridge

The minimum distance from the centerline of alignment Alternative 6.2 to the closest receiver property is 10 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB threshold for Residential and 75 VdB threshold Institutional land uses.

The Arts West Theater is located 50 feet from alignment Alternative 6.2, corresponding to vibration levels of 53.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the maximum 72 VdB vibration threshold for theaters. Therefore, no vibration impact to the Arts West Theater is expected.

Along California Avenue SW, the minimum distance from the centerline of Alternative 6.2 to the closest receiver property is 10 feet, corresponding to vibration levels of 65.4 VdB re 1 micro inch/sec at the receiver property line. The predicted future vibration levels are below the 72 VdB threshold for Residential and 75 VdB threshold for Institutional land uses.

The closest Historic Building is WS-154, Residence, 5956-5958 California Avenue SW, located 20 feet from alignment Alternative 6.2. The corresponding vibration levels at this Historic Building from Green Line operations are 61.4 VdB re 1 micro inch/sec. The predicted future vibration levels are below the 72 VdB threshold for this land use and well below the 95 VdB threshold for architectural damages to extremely fragile historic buildings.

#### West Seattle Segment Summary

Since all sensitive land uses are below the maximum vibration threshold, no vibration impacts would be expected with Alternatives 6.1 and 6.2. The increased distance along California Avenue SW from the centerline of alignment Alternative 6.1 to the closest building structures results in a lower overall impact of this alignment compared with Alternative 6.2. All of the alignment options in the West Seattle Segment (6.1.1, 6.1.2, 6.1.3, and 6.1.4) would result in similar vibration impacts.

#### **All Station Alternatives**

At all stations, vibration levels at the base of the support columns would be below the maximum vibration levels for High Sensitivity land uses (65 VdB re 1 micro inch/sec) due to the reduced train speed approaching and leaving the station. Therefore, no vibration impacts from Green Line operations are expected at stations.

Ground-borne vibration levels vary at approximately 20 times the logarithm of the speed of the train. This means that doubling the train speed would increase the vibration levels approximately 6 VdB re 1 micro inch/sec and halving the speed would reduce the level by 6 VdB re 1 micro inch/sec. Table 4.7-16 shows the predicted vibration levels at stations under a variety of operating conditions.

#### **4.7.2.4 Noise and Vibration Impacts from Construction**

Construction of the Green Line would generate various noise and vibration impacts depending on the type of equipment used, distance to closest receivers, and soil conditions. Refer to Section 4.17, Construction, for the construction noise and vibration impact analysis and mitigation measures.

**Table 4.7-16. Predicted Vibration Levels at Stations**

Description	Vibration Level
Two trains at 25 mph in opposite direction with maximum braking	73.8 VdB
Two trains at 25 mph in opposite direction with maximum acceleration	73.9 VdB
At column base two trains at 25 mph in opposite direction with maximum braking	63.8 VdB
At column base two trains at 25 mph in opposite direction with maximum acceleration	63.9 VdB
At column base two trains at 10 mph in opposite direction with maximum braking	55.8 VdB
At column base two trains at 10 mph in opposite direction with maximum acceleration	55.9 VdB
At column base two trains at 5 mph in opposite direction with maximum braking	49.8 VdB
At column base two trains at 5 mph in opposite direction with maximum acceleration	49.9 VdB

RMS velocity Levels, VdB re 1 micro inch/sec.

#### **4.7.2.5 No Action Alternative Impacts**

The No Action Alternative would not create noise or vibration impacts to any buildings adjacent to the Green Line corridor.

#### **4.7.3 Mitigation**

##### **4.7.3.1 Noise Mitigation**

Because the noise analysis identified potential impacts associated with Green Line alternatives, it is necessary to consider mitigation measures to reduce or eliminate such impacts. The following section considers potential mitigation measures that could be implemented to reduce noise impacts related to operation of the Green Line. For discussion of the mitigation measures related to potential impacts related to construction noise, refer to Section 4.17, Construction.

Based on the modeling assessment conducted for this evaluation, it was preliminarily determined that sound levels from Green Line trains would need to be reduced from 3 to 14 dBA to avoid impacts at all residential use locations along the alternative alignments. There appear to be a number of potential methods of reducing noise transmission from the trains. These could include one or more of the following measures:

- Creating design specifications for train cars that limit their noise levels by incorporating shielding of noise-producing areas or absorptive materials, or by other means.
- Creating design specifications for guideways and stations that enable them to block noise from Green Line trains by incorporating blocking or absorptive materials or by other means.
- Reducing travel speeds in sensitive areas.
- Providing insulating or absorptive materials or other means of shielding to dampen sound penetration to nearby properties.

Specific mitigation measures for each affected location would be designed and their efficacy confirmed with additional noise modeling based on the actual design of the Green Line.

Table 4.7-17 presents findings of some of the initial considerations of possible noise mitigation measures for the Green Line. Based on this review, it appears highly likely that effective noise mitigation measures could be developed and implemented once the alignment of the Green Line has been decided.

**Table 4.7-17. Potential Noise Control Mitigation Measures**

<b>Method</b>	<b>Possible Effects</b>	<b>Comments</b>
Travel speed reductions over entire day in impact areas	Direct reduction of noise associated with tire noise on the guideway. Preliminary examination indicates reductions of about 2.3 dBA for each 5 mph reduction. Reducing speed at all times by 5 mph would reduce Ldn by about 2.3 dBA.	Would affect performance of system. Would provide sufficient reduction to avoid impacts in some areas.
Travel speed reductions during some noise-sensitive nighttime hours	Reducing speed 10 mph during hours of 2200-2400 and 0500-0600 reduces Ldn about 1.4 dBA	Would not affect peak use hours, but would not have much effect on daylong sound levels. Would provide sufficient reduction to avoid impacts in a few areas.
Travel speed reductions during all noise-sensitive nighttime hours	Reducing speed 10 mph during hours of 2200-2400 and 0500-0700 reduces Ldn about 2.7 dBA	Would affect one peak use hour, but would have somewhat greater effect on daylong sound levels. Would provide sufficient reduction to avoid impacts in some areas.
Travel speed reductions (5 mph) over entire day in impact areas AND 5 mph reductions during some or all noise-sensitive nighttime hours	Reducing the speed 5 mph over the entire day and also reducing the speed an additional 5 mph during 3 nighttime hours reduces the Ldn by 3.1 dBA [-3.8 dBA with all four nighttime hours]	Would provide sufficient reduction to avoid impacts in some areas. Most effective scenario affects one peak use hour.
Travel speed reductions (5 mph) over entire day in impact areas AND 10 mph reductions during some or all noise-sensitive nighttime hours	Reducing the speed 5 mph over the entire day and also reducing the speed an additional 10 mph during 3 nighttime hours reduces the Ldn by 3.7 dBA [-5.0 dBA with all four nighttime hours]	Would provide sufficient reduction to avoid impacts in many areas. Most effective scenario affects one peak use hour.
Using quietest available onboard equipment and treating the equipment and/or the equipment compartments to control noise	Could provide substantial reductions in uncontrolled levels of equipment-related sound levels. This type of control is very feasible.	Most effect in noise reductions for trains moving at slower speeds and at stations.
Adding mass and/or additional skirting to reduce transmission of tire noise	This sort of control is largely undocumented.	Significant control of tire noise may be possible, but raises the issue of additional weight.
Guideway noise barriers	Could provide substantial reductions if strategically placed.	Could be unsightly and would add weight to the guideway.
Noise control measures to reduce interior sound levels in sensitive uses that would otherwise be affected	Could substantially reduce interior levels; has no effect on exterior levels.	Retrofits require custom applications, are labor intensive, and can be expensive.
Combination of the above	Could provide substantial noise reductions.	Requires more complete analysis based on the actual design of the Green Line and development of information regarding the guideway horizontal and vertical alignments and the physical geometry of nearby land and buildings.

Source: MFG, Inc. and Lea & Elliott

#### **4.7.3.2 Vibration Mitigation**

The purpose of vibration mitigation is to minimize adverse effects that ground-borne vibration could have to adjacent properties. This section describes mitigation measures that could be implemented for vibration impacts.

For all Green Line alignment alternatives, a minimum 10-foot separation from support columns to any residential land use would reduce the vibration level to 65.4 VdB re 1 micro inch/sec, below the residential vibration threshold of 72 VdB. Since columns are expected to be located at least 10 feet away from residential land uses for any of the Green Line alternatives, no additional mitigation would be required.

For high sensitivity land uses such as Friedman & Bruya, Inc. at 3012 16<sup>th</sup> Avenue W in the Interbay Segment, a 20-foot separation from the closest support column to the existing building would result in a vibration level of 61.4 VdB re 1 micro inch/sec. This is lower than the 65 VdB re 1 micro inch/sec maximum vibration level for this sensitive receiver. Therefore, no additional mitigation would be required since columns for Alternative 2.1 would be located at least 20 feet from the building.

In addition, an effective maintenance program should be implemented for controlling ground-borne vibration. This should include standard vehicle maintenance checks on the vehicle tires, tire pressure, and suspension system. A regular check of the guideway surfaces should also be part of the structural maintenance program to maintain a smooth concrete surface for Green Line trains to ride on.

#### **4.7.4 Significant Unavoidable Adverse Impacts**

Without effective implementation of mitigation measures, operational noise from the Green Line could cause significant noise impacts at numerous residences along the proposed route. Potentially significant noise impacts have been identified in the following areas: along 15<sup>th</sup> Avenue NW in Ballard; along W Harrison Street, along Fifth Avenue between Bell and Lenora Streets, and along Second Avenue between Pine and Marion Streets in the Downtown Segment; and in West Seattle along SW Yancy Street, in the Avalon area, and along California Avenue SW between SW Hudson and SW Holly Streets.

No significant unavoidable adverse vibration impacts are expected with the construction or operation of the Green Line.

## 4.8 ENERGY

This section summarizes current transportation-related energy use in the Puget Sound region and quantifies the future operational and construction energy use from the Green Line.

### 4.8.1 Affected Environment

This analysis focuses on existing transportation-related energy use in the Puget Sound region. For the affected environment, the transportation energy analysis identifies energy consumed by automobiles, trucks, buses, and motorcycles (not including boats, trains, and planes). Table 4.8-1 summarizes the average daily energy consumption for transportation uses in the Puget Sound region (Seattle-Everett and Tacoma urbanized areas) in 2001. Vehicle miles traveled (VMT) was estimated for the Puget Sound region by the Puget Sound Regional Council (PSRC). Vehicle mix and average fuel consumption data were used with multipliers from the Transportation Energy Data Book (U.S. Department of Energy 2002) to estimate daily energy consumption for the region. Average weekday regional VMT used approximately  $499.089 \times 10^9$  British thermal units (Btu) of energy in 2001. Energy is also consumed to maintain and repair vehicles (oil, tires, and general maintenance and repair) and can also be calculated using VMT and multipliers from the Transportation Energy Data Book. Vehicle maintenance adds  $70.694 \times 10^9$  Btu to daily regional energy consumption.

Transportation-related energy use within Seattle consists of automobiles, trucks, buses, motorcycles, trains, and ferries. Most vehicles are powered by gasoline and diesel. Nineteen King County Metro trolley bus routes are powered by electricity.

**Table 4.8-1. Existing Motor Vehicle Energy Consumption in the Puget Sound Region (2001)**

Vehicle Type	Percent of VMT <sup>a</sup>	Daily VMT <sup>b</sup>	Average Fuel Consumption (miles per gallon) <sup>a</sup>	Daily Fuel Consumption (gallons)	Daily Energy Consumption (Btu x 10 <sup>9</sup> )
Light-duty gas automobiles	47.3	31,176,460	23.61	1,320,477	165.060
Light-duty gas trucks 1	26.9	17,732,111	18.53	956,941	119.618
Light-duty gas trucks 2	11.5	7,577,881	14.21	533,278	66.660
Heavy-duty gas vehicles	4.5	2,974,668	7.87	378,096	47.262
Light-duty diesel automobiles	0.1	84,252	26.41	3,190	0.442
Light-duty diesel trucks	0.2	153,276	19.23	7,971	1.106
Heavy-duty diesel vehicles	9.0	5,906,089	8.35	707,570	98.140
Motorcycles	0.5	320,264	50.00	6,405	0.801
<b>Subtotal</b>	<b>100</b>	<b>65,925,000</b>		<b>3,913,928</b>	<b>499.089</b>
Vehicle maintenance					70.694
<b>Total</b>					<b>569.783</b>

Notes: Btu per gallon of gasoline = 125,000. Btu per gallon of diesel = 138,700.

Light-duty trucks 1 = Trucks up to 6,000 pounds gross vehicle weight.

Light-duty trucks 2 = Trucks from 6,000 to 8,500 pounds gross vehicle weight.

Heavy-duty trucks = Trucks over 8,500 pounds gross vehicle weight.

<sup>a</sup> Share of vehicle miles traveled (VMT) by vehicle type and average fuel consumption by vehicle type is from Washington State Department of Ecology (Ecology 2003).

<sup>b</sup> VMT was calculated for the Puget Sound Region, which includes the Seattle-Everett and Tacoma urbanized areas (PSRC 2001).

Sources: Ecology (2003); PSRC (2001); U.S. Department of Energy (2002).



## 4.8.2 Impacts

### 4.8.2.1 Green Line Alternatives

Direct impacts are characterized by the energy that would be consumed by operation of the Green Line. The energy consumed by the Green Line includes operation of monorail trains, transit stations, equipment rooms, and the Operations Center. Energy for potential guideway heating for snow and ice removal on the guideway surfaces and power/signal rails is also considered, although current plans do not include heating the guideway. The tentative recommendation not to heat the guideway is based on an analysis of monorail operations during inclement weather (Lea+Elliott 2003a). Based on National Weather Data Service 30-year temperature and precipitation averages, the analysis concluded that local weather is not concurrently cold and wet enough to create significant ice formation and necessitate guideway heating. During times when frost or ice is expected to form, operating trains on a normal schedule would be sufficient to keep the guideway clear.

Green Line operational energy use was provided by Lea+Elliott. Lea+Elliott's work explains the results of a preliminary power analysis performed for one of the build alternatives (Lea+Elliott 2003b). The detailed simulation results used to calculate these estimates are provided in an analysis by Lea+Elliott (Lea+Elliott 2003c). In order to determine potential energy usage for the Green Line, an analysis of the individual route and station alternatives is not required because all alternatives would use a similar amount of energy. Total distance traveled, number of stations, grade, and/or curve radii are the main factors in monorail power usage. The alternatives are not different enough with respect to these conditions to have a significant difference in power usage (Harris 2003).

Table 4.8-2 summarizes the projected daily operational energy demand for the Green Line. It is estimated that Green Line operations would use  $0.590 \times 10^9$  Btu daily if there is no guideway heating and  $0.593 \times 10^9$  Btu daily with guideway heating. It is estimated that Green Line-related energy consumption would represent approximately 0.1 percent of the existing regional energy use for transportation, a relatively small percentage of the region's transportation energy use.

Seattle City Light has indicated that the estimated power demand for the Green Line would not cause adverse impacts to the local power supply (Davis 2003). For comparison purposes, Seattle City Light provided monthly energy use for other large-load electricity customers. On a monthly basis, SMP would consume less than one seventh of the energy used by Nucor Steel, a local steel mill (Seattle City Light 2003).

**Table 4.8-2. Green Line Daily Operational Energy Use in Btu**

Type of Energy Use	Daily Energy Use
Train propulsion	0.318
Operations Center	0.123
Stations	0.072
Equipment rooms	0.077
<b>Total Green Line system energy use</b>	<b>0.590</b>
Optional guideway heating <sup>b</sup>	0.003
<b>Total Green Line energy use with guideway heating</b>	<b>0.593</b>

<sup>a</sup> Values provided in  $10^9$  Btu.

<sup>b</sup> Guideway heating based on 480 hours of heating.

Source: Lea+Elliott (2003b).

While the Green Line could consume additional electrical energy over the No Action Alternative, it would reduce the energy consumed by motor vehicles for trips made on the Green Line instead of motor vehicles (see Section 4.1.2, Table 4.1-7 Transportation). As people choose to travel on the Green Line, some vehicle trips would be shortened or eliminated. Although not possible to predict with precision, the energy savings from the reduction in vehicle trips would partially or fully offset the power requirements of the Green Line.

Power rails mounted to the guideway beam supply the electricity used to power the vehicles' electric motors (Lea+Elliott 2003b). The types of electric motors and motor controllers are dependent on the selection of the monorail train supplier. These rails would have either 750 volts Direct Current (DC) or 1,500 volts DC depending on the selected train supplier. Ten to 20 traction power substations would be constructed along the Green Line alignment to distribute power throughout the system. The number of substations would depend on whether all substations are built with redundant power supply (10 substations needed) or whether each has only a single source (20 substations needed) (Lea+Elliott 2003b). Upgrades to some power transmission lines may be required; impacts to transmission lines and other utilities are discussed in Section 4.9, Public Services and Utilities.

SMP is coordinating with Seattle City Light to ensure a reliable source of power for the Green Line and to minimize impacts to Seattle City Light facilities and resources. This reliability would be achieved by Seattle City Light providing redundant (dual) feeders. It is anticipated that the train propulsion system substations will be supplied by common feeders from one or two Seattle City Light sources. The number of sources needed will depend on Seattle City Light's infrastructure at the time the power is needed for the Green Line. Each passenger station and the Operations Center will be powered by separate electrical service connections.

To maximize the power consumption efficiency of the monorail trains and ensure good power quality, the monorail system supplier will be required to maintain a minimum average power factor of 0.95 and to comply with Institute of Electrical and Electronics Engineers, Inc. Standard 519-1992. The peak line load Kilo-Volt-Amperes (KVA) for any 15-minute period and the average KVA demand estimated are provided in Table 4.8-3. Peak energy demand would most likely occur when peak operation times (6:00 a.m. to 9:00 a.m. and 4:00 p.m. to 7:00 p.m.) coincide with periods of extreme weather. The monorail trains would be heated during periods of cold weather and could potentially be air-conditioned during periods of hot weather. In addition, to prevent ice formation on the guideway (if the guideway is not heated), the system would operate on a normal peak period schedule during cold weather periods.

**Table 4.8-3. Green Line Operational Energy Use in KVA**

	<b>Average KVA</b>	<b>Peak KVA</b>
Train propulsion	15,000	19,000
Operations Center	750	1,500
Stations (including equipment rooms)	100	200
<b>Total</b>	<b>15,850</b>	<b>20,700</b>
Guideway power rail heating <sup>a</sup>	3,000	3,000
<b>Total</b>	<b>18,850</b>	<b>23,700</b>

<sup>a</sup> KVA values for guideway power rail heating are only applicable when the system is turned on during snow/icing conditions.

The monorail train supplier may reduce these peak and average KVA estimates by utilizing regenerative braking (electrical power generation during train deceleration). This generated power would be available for consumption by other trains in the system. The monorail system supplier would be required to comply with all applicable Seattle City Light codes and regulations for electrical service connections, and all monorail system electrical switchgear would be coordinated with Seattle City Light.

#### **4.8.2.2 No Action Alternative**

The No Action Alternative would not require energy for Green Line operations; however, energy savings would not be realized from reduced vehicle trips.

#### **4.8.3 Mitigation**

SMP will work with Seattle City Light to implement SMP's environmental sustainability policies as it designs facilities. Where appropriate, electricity conservation measures and electrical system specifications for supply will be implemented. The Green Line would incorporate relevant City of Seattle and Washington State energy code requirements into design where appropriate (for example, energy-efficient lighting, mechanical equipment, and building insulation). No additional measures are necessary to mitigate the anticipated energy use of the Green Line.

#### **4.8.4 Significant Unavoidable Adverse Impacts**

No significant unavoidable adverse energy impacts are expected as a result of any of the Green Line Alternatives.

## 4.9 PUBLIC SERVICES AND UTILITIES

### 4.9.1 Affected Environment

#### 4.9.1.1 Affected Environment – Public Services

This section evaluates the effects of the Green Line on public services located near or providing services in the vicinity of the Green Line alternative alignments. Public services analyzed include police, firefighting, emergency medical response, public and private schools, U.S. Post Offices, and solid waste collection. Several federal government facilities are also noted in the Downtown Segment, which is the only segment with major federal facilities within close proximity of the alignment alternatives. More specifically, public services include:

- **Police.** The Seattle Police Department's north, west, and southwest precincts provide police services for the neighborhood segments that would be served by the Green Line. Table 4.9-1 lists precincts by location.
- **Port of Seattle.** In the Interbay and SODO Segments, the Green Line project would cross property controlled by the Port of Seattle, which provides its own police services in addition to services provided by the Seattle Police Department.
- **Fire.** The Seattle Fire Department has sixteen stations that serve the communities along the Green Line alternative alignments. Table 4.9-2 lists stations that provide fire protection and emergency medical services within the segments.
- **Hospitals.** Although there are no hospitals directly on any of the Green Line alternative alignments, emergency services are provided at nine hospitals in the project area, as listed in Table 4.9-3.
- **Schools.** Table 4.9-4 lists public and private schools along the Green Line alternative alignments. School buses also use streets (such as 15<sup>th</sup> Avenue NW, NW 75<sup>th</sup> Street, NW 65<sup>th</sup> Street, and California Avenue SW) that may be affected by the Green Line project.
- **Post Office.** There is one U.S. Post Office along the Green Line route in the Interbay Segment, at 2010 15<sup>th</sup> Avenue W. There are several U.S. Post Offices located one to three blocks from the Green Line alternative alignments in the Downtown and SODO Segments.
- **Solid Waste.** There are no solid waste or recycling facilities near the alternative alignments, monorail stations, or Operations Centers. However, solid waste disposal and recycling trucks use the same surface streets proposed for location of monorail guideway columns and stations.

Figures 4.9-1 through 4.9-5 identify service providers in the vicinity of the Green Line alternative alignments.

**Table 4.9-1. Seattle Police Precincts Serving the Green Line Route**

Segment	Station	Location
Ballard	North	10049 College Way N
Interbay, Queen Anne/Seattle Center/ Belltown, Downtown, SODO	West	810 Virginia Street
West Seattle	Southwest	2300 SW Webster

**Table 4.9-2. Seattle Fire Department Stations Serving the Green Line Route**

Segment	Station	Location	Equipment
Ballard	35	8729 15 <sup>th</sup> Avenue NW	Engine 35
Ballard	21	7304 Greenwood Avenue N	Engine 21
Ballard	18	1521 NW Market Street	Engine 18, Hose 18, Medic 18 Ladder 8, Battalion 4
Interbay	23	Fishermen's Terminal	Engine 3 (Reserve Fireboat)
Interbay	8	110 Lee Street	Engine 8 and Ladder 6
Interbay	9	3829 Linden Avenue N	Engine 9 and Air 9
Interbay	20	3205 13 <sup>th</sup> Avenue W	Engine 20
Interbay	41	2416 34 <sup>th</sup> Avenue W	Engine 41
Downtown	2	2334 Fourth Avenue	Aid 2, Ladder 4, Engine 2, Safety 2
Downtown	10	301 Second Avenue S (department headquarters)	Aid 5, Ladder 1, Engine 10, Staff 10, Air 10, Deputy 1, and Hazardous Materials Unit
Downtown	5	925 Alaskan Way	Engine 4 (fireboat) and Engine 5
SODO	14	3224 Fourth Avenue S	S Ladder 7, Aid 14, Rescue 14
West Seattle	36	3600 23 <sup>rd</sup> Avenue SW	Engine 36 and Marine Response
West Seattle	37	7300 35 <sup>th</sup> Avenue SW	Engine 37
West Seattle	32	3715 SW Alaska Street	Medic 32, Ladder 11, Engine 32
West Seattle	29	2139 Ferry Avenue SW	Engine 29 and Battalion 7

Note: Some of the stations listed provide coverage beyond the project segment in which they are located.

Source: Seattle Fire Department (2003).

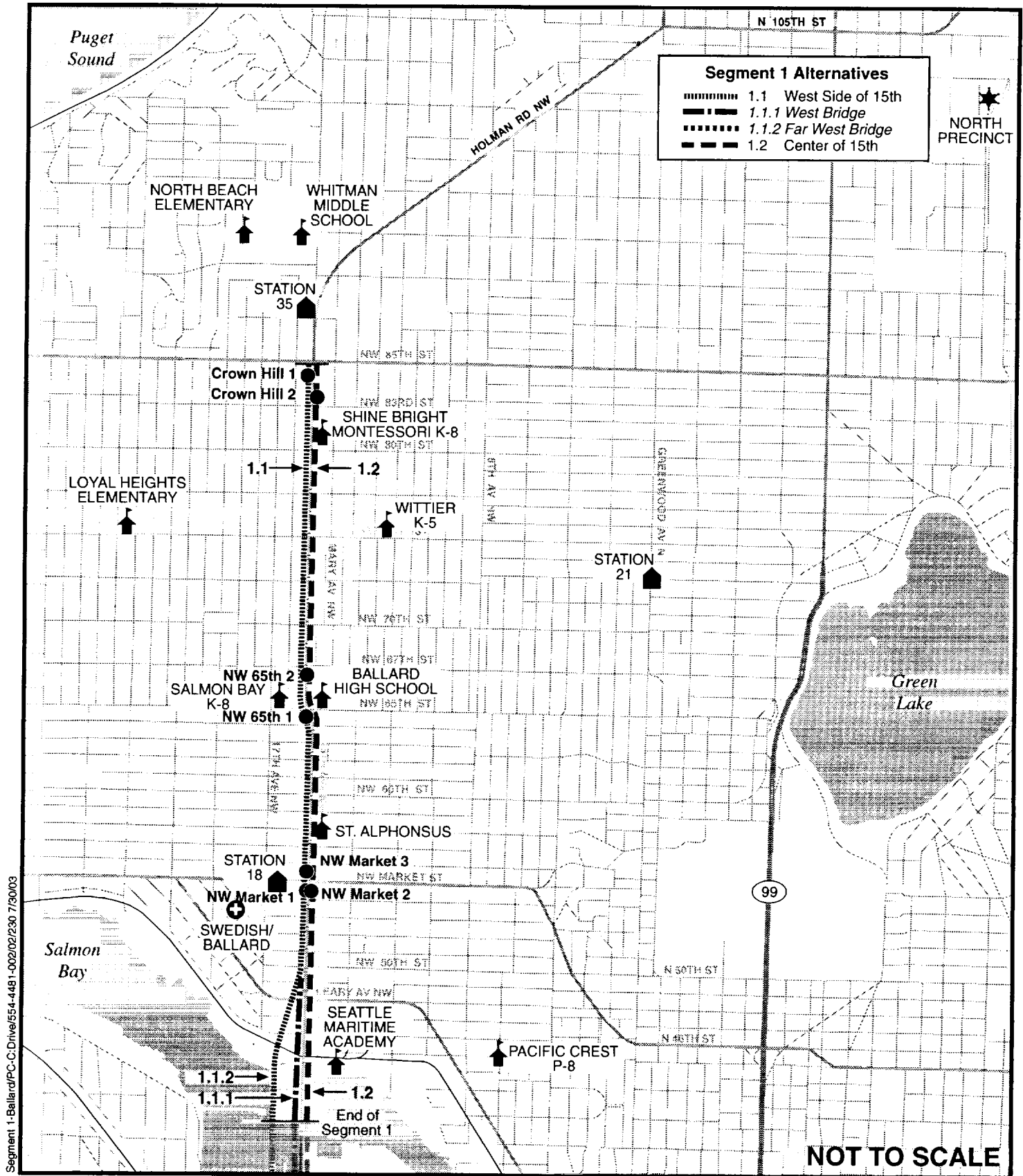
**Table 4.9-3. Hospitals Serving the Green Line Route**

Nearest Segment	Hospital	Location
Ballard	Swedish Medical Center/Ballard	5300 Tallman Avenue
Queen Anne/Seattle Center/Belltown	Group Health Medical Center	201 16 <sup>th</sup> Avenue E
Downtown	Harborview Medical Center	325 Ninth Avenue
Downtown	Swedish Medical Center	747 Broadway
Downtown	Swedish Medical Center at Providence	500 17 <sup>th</sup> Avenue
Downtown	Providence Health Systems	506 Second Avenue
Downtown	Virginia Mason	925 Seneca Street
Downtown	Regence Care & Clinical Options	1800 Ninth Avenue
SODO	Pacific Medical Center	1101 Madison

**Table 4.9-4. Public and Private Schools within the Vicinity of the Green Line Alternative Alignments**

<b>Segment</b>	<b>School</b>	<b>Location</b>
Ballard	North Beach Elementary	9018 24 <sup>th</sup> Avenue NW
Ballard	Whitman Middle School	9201 15 <sup>th</sup> Avenue NW
Ballard	Shine Bright Montessori	8015 15 <sup>th</sup> Avenue NW
Ballard	Loyal Heights Elementary	2511 NW 80 <sup>th</sup> Street
Ballard	Whittier K-5 Elementary	1320 NW 75 <sup>th</sup> Street
Ballard	Salmon Bay K-8	1810 NW 65 <sup>th</sup> Street
Ballard	Ballard 9-12 High School	15 <sup>th</sup> Avenue NW/NW 65 <sup>th</sup> Street
Ballard	Saint Alphonsus	5816 15 <sup>th</sup> Avenue NW
Ballard	Seattle Maritime Academy	4455 Shilshole Avenue NW
Ballard	Pacific Crest	600 NW Bright Street
Interbay	Lawton Elementary	4000 27 <sup>th</sup> Avenue W
Interbay	Seattle Country Day School	2619 Fourth Avenue N
Interbay	Coe Elementary	2424 Seventh Avenue W
Interbay	McClure Middle School	1915 First Avenue W
Interbay	John Hay Elementary	201 Garfield Street
Interbay	St. Anne	101 W Lee Street
Queen Anne/Seattle Center/Belltown	Center High School	Center House, Seattle Center
Downtown	Gatzert Elementary	1301 East Yesler Way
SODO	Beacon Hill Elementary	2025 14 <sup>th</sup> Avenue S
West Seattle	West Seattle High School	3000 California Avenue SW
West Seattle	West Seattle Montessori	4536 38 <sup>th</sup> Avenue SW
West Seattle	Seattle Lutheran	4141 41 <sup>st</sup> Avenue SW
West Seattle	Hope Lutheran	4446 42 <sup>nd</sup> Avenue SW
West Seattle	West Seattle Christian	4401 42 <sup>nd</sup> Avenue SW
West Seattle	Pathfinder Elementary	5012 SW Genesee Street
West Seattle	Fairmount Park K-5	3800 SW Findlay Street
West Seattle	Gatewood K-5 Elementary	4320 SW Myrtle Street
West Seattle	High Point Elementary	6760 34 <sup>th</sup> Avenue SW

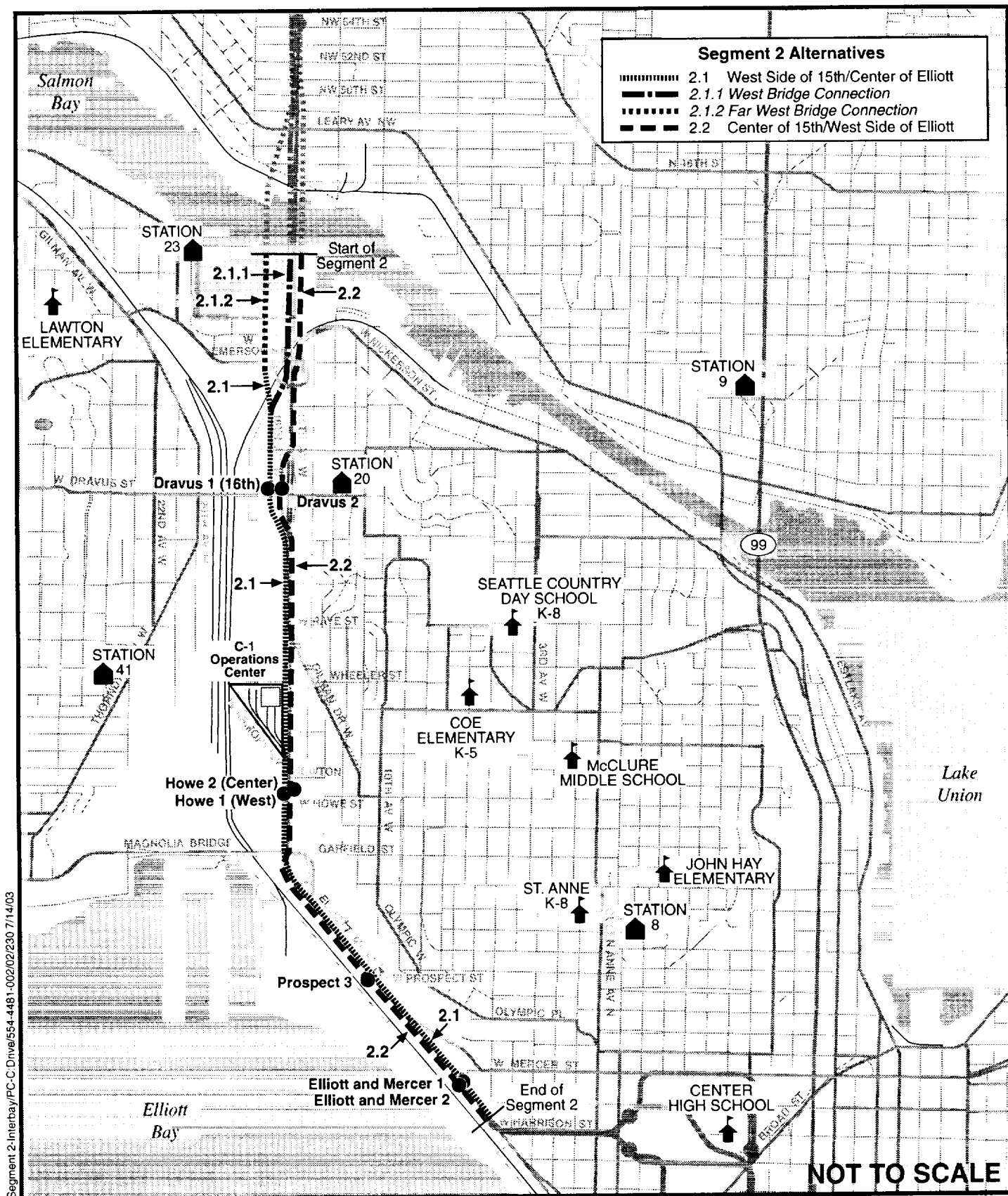
Sources: Seattle School District Web Site (2003), Seattle Times School Guide (2003).



SEATTLE MONORAIL PROJECT



**Figure 4.9-1  
Segment 1: Ballard  
Public Services**



Segment 2-Interbay/PC-C Drive/554-4481-002/02/230 7/14/03

SEATTLE MONORAIL PROJECT



- ★ Police
- Firestations
- ⊕ Hospitals
- 🏫 Schools

**Figure 4.9-2**  
**Segment 2: Interbay**  
**Public Services**



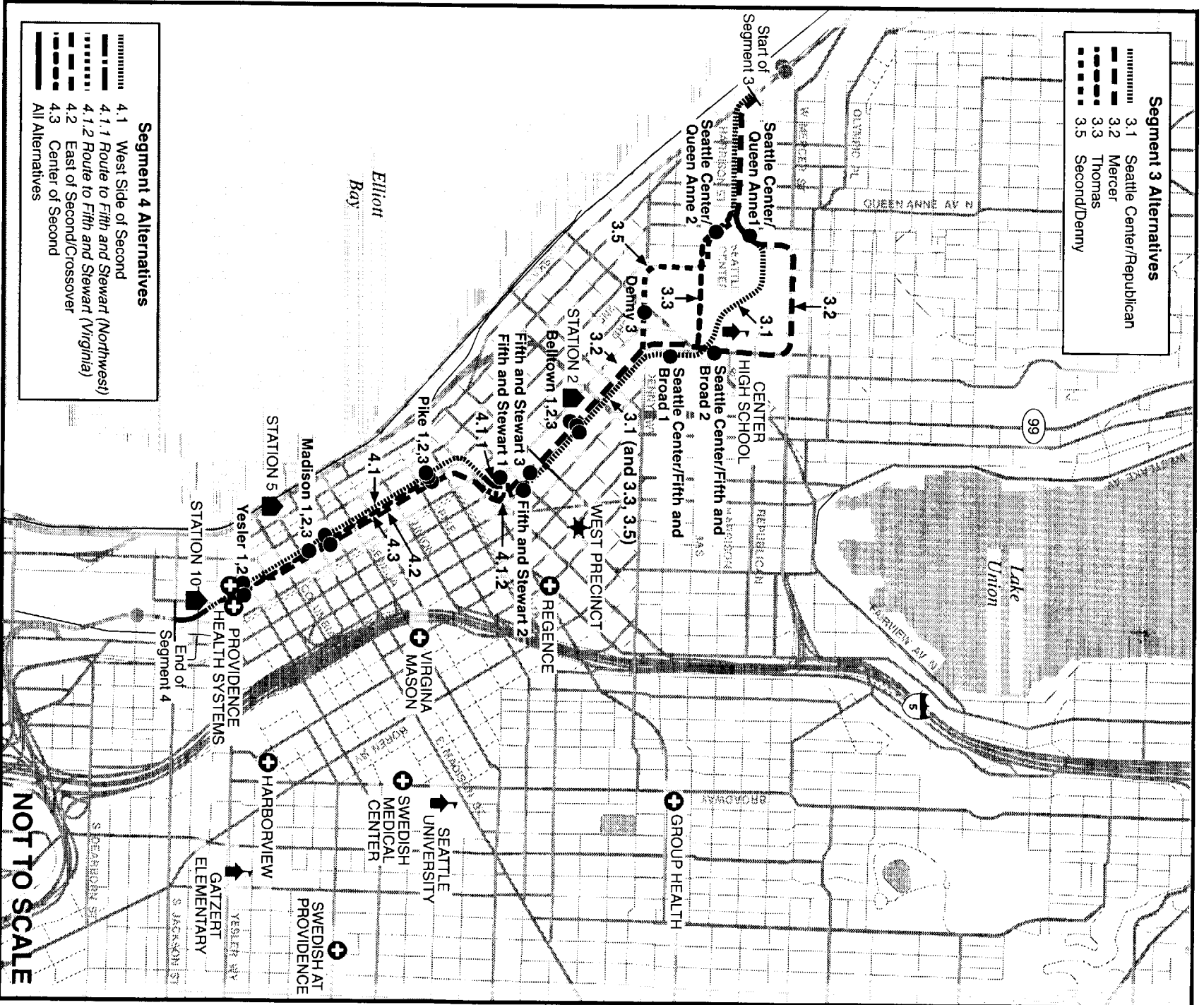
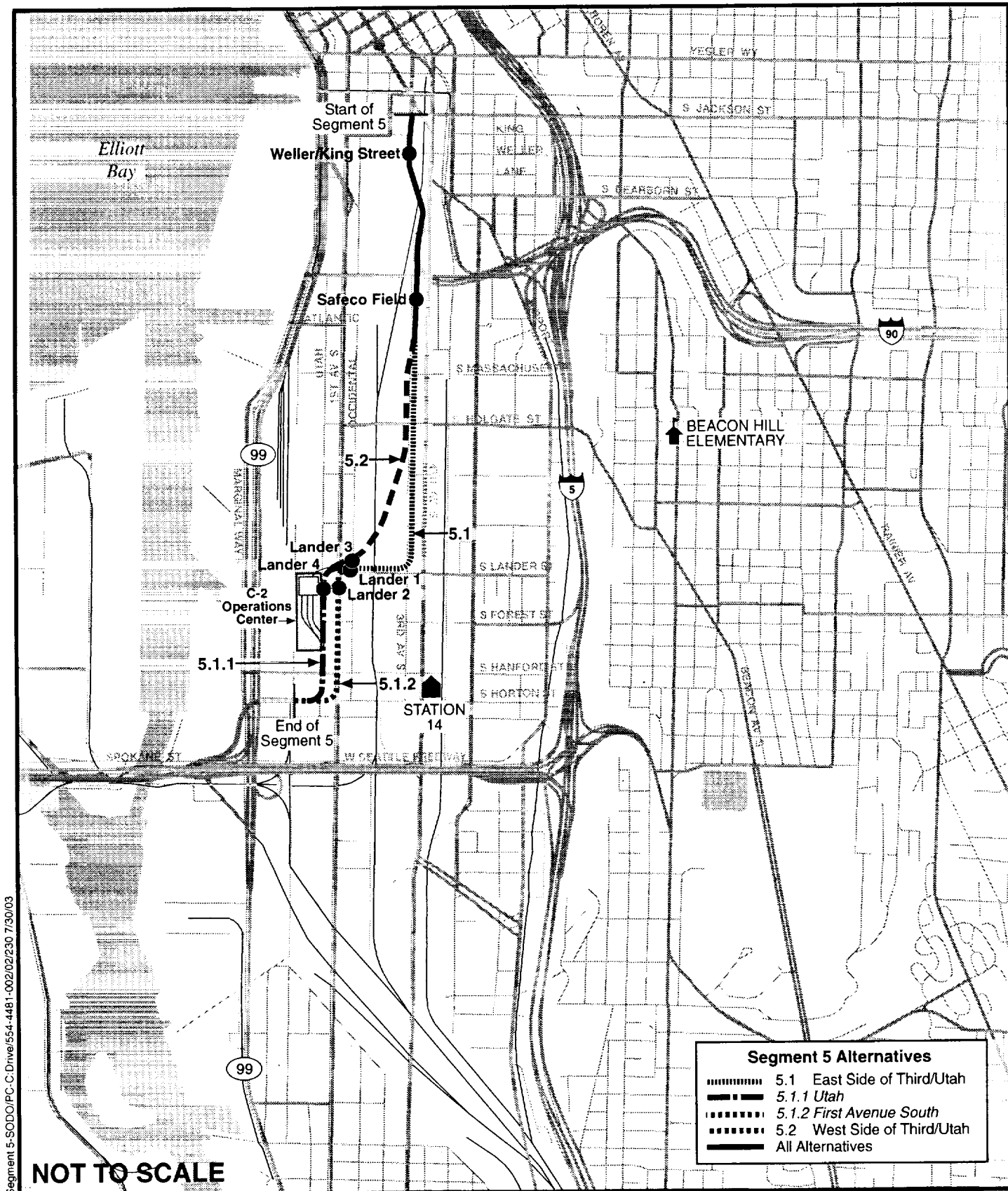


Figure 4.9-3  
Segments 3 and 4: Queen Anne/  
Seattle Center/Belltown/Downtown  
Public Services



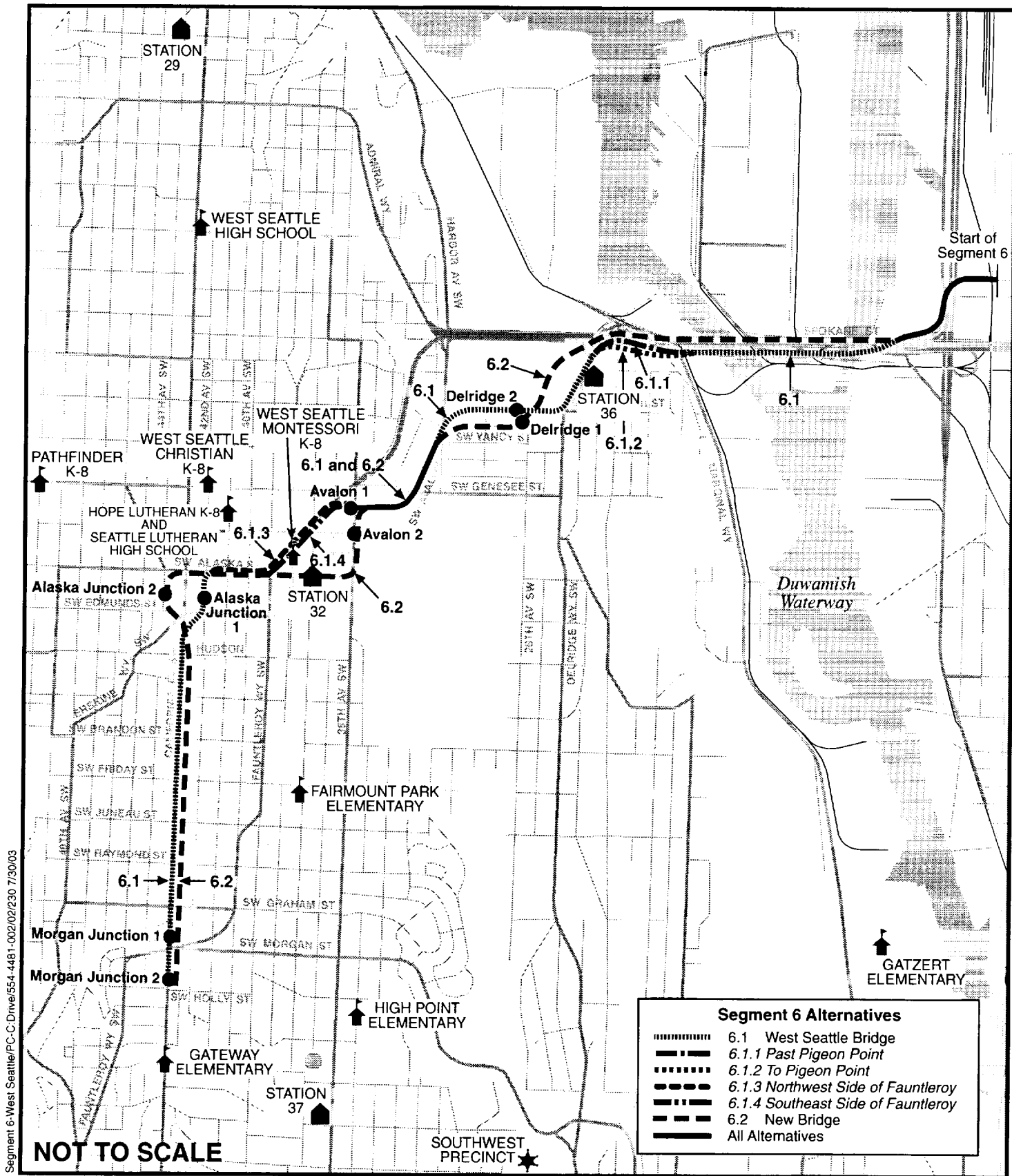
Segment 5-SODO/PC-C Drive/554-4481-002/02/230 7/30/03

SEATTLE MONORAIL PROJECT

- ★ Police
- 🚒 Firestations
- 🏥 Hospitals
- 🎓 Schools



**Figure 4.9-4  
Segment 5: SODO  
Public Services**



**Figure 4.9-5  
Segment 6: West Seattle  
Public Services**

#### **4.9.1.2 Affected Environment – Utilities**

There are a number of utility providers along the Green Line alignment alternatives, including municipal agencies and private companies that provide electricity, water, wastewater and stormwater collection, natural gas, and telecommunications services. The construction and operation of the Green Line would be largely within public street rights-of-way, where utilities also tend to be located.

The existing utilities in the six segments are discussed in more detail in Section 4.17, Construction. However, major utility providers in the project area, which is entirely within the city of Seattle, are the same regardless of the segment. The major providers in the project area include:

- **Electrical Service.** Seattle City Light (City Light), a department of the City of Seattle, provides electric power to more than 345,000 customers in a 131.1-square-mile service area that includes Seattle and portions of King County. City Light owns nearly 1,900 megawatts of hydroelectric generation capacity and owns or contracts approximately 80 percent of its hydroelectric generating needs (City Light 2003a). A City-owned circuit of 657 miles of transmission lines carries power from the generating facilities to 14 major substations and 12 unit substations. City Light also owns and maintains a distribution circuit of 3,100 miles (City Light 2003b). In the study area, the City Light system uses a combination of electrical transmission and distribution lines. The transmission lines are typically 34 to 240 kilovolts (kV) arranged with a set of three conductors placed in-line vertically (spaced 5.5 feet), while distribution lines range between 4 to 26 kV under the same configuration (BERGER/ABAM 2003a). Notable underground electrical duct banks (EDs) are located along the west side of Second Avenue. Overhead transmission lines are located crossing S Massachusetts and Third Avenue S, at the east approach to West Seattle Bridge, and at Utah Avenue S and S Hanford Street.
- **Water Supply.** Seattle Public Utilities (SPU) provides potable (drinkable) water to nearly 600,000 people in Seattle and surrounding areas. Two water sources, the 90,000-acre Cedar River Watershed and the 13,300-acre South Fork Tolt River Watershed, provide most of the service area's annual average consumption of 145 million gallons per day (SPU 2000). The system consists of transmission and distribution mains, fire hydrants, water meters, service lines, and water valve chambers. In the project area, the primary water mains range in size between eight and 20 inches and are typically located along the east side of north-south streets (BERGER/ABAM 2003a,c).
- **Sanitary Sewer and Stormwater.** SPU owns, operates, and maintains sewer collection facilities, including pipelines and other wastewater conveyance facilities, in Seattle. SPU inspects, repairs, operates, and maintains wastewater (sewer) pipes and pump stations in the project area to protect public health and avoid property and environmental damage from sanitary sewer overflows and combined sewer system overflows (SPU 2001). The King County Department of Natural Resources Wastewater Treatment Division provides sewage treatment services throughout the project area and also owns, operates, and maintains regional sewer conveyance pipelines. Wastewater in the project vicinity is conveyed to King County's West Point Treatment Plant, which operates at a capacity of 133 million gallons per day (King County 2003). Sewer mains in the project area range in size from eight to 24 inches, with a 30-inch line along SW Andover and a 36-inch line along the west side of Third Avenue. Other primary sewer mains in the project area are located along the center of 15<sup>th</sup> Avenue NW, west side of 15<sup>th</sup> Avenue W, center of Elliott Avenue, and the center of Utah Avenue S. Within the Downtown Segment, a 102-inch Metro combined sewer tunnel is located along the center of Second Avenue from Stewart Street to S Washington Street. The depth of this tunnel ranges from approximately

100 feet at Stewart Street to approximately 30 feet at S Washington Street (BERGER/ABAM 2003a,c).

Stormwater in Seattle is collected by storm sewers; a combined stormwater and wastewater system; or through a ditch, culvert, and creek system. SPU operates and maintains these drainage systems and also constructs new trunk lines and detention ponds to alleviate flooding problems. In the project area, the primary storm drains range in size between 8 and 21 inches and are located along the west side of 15<sup>th</sup> Avenue NW, west side and center of 15<sup>th</sup> Avenue W, west side of Elliott Avenue W, and the east side of Utah Avenue S (BERGER/ABAM 2003a,c).

- **Natural Gas.** Puget Sound Energy (PSE) provides natural gas service throughout the project area. PSE serves more than half of the residents of Washington State over a 6,000-square-mile service area. Their 620,000 natural gas customers are primarily in Western Washington (PSE 2003a,b). Natural gas pipes are located within the project vicinity in each segment. The primary high-pressure lines are located along Elliott Avenue W and 35<sup>th</sup> Avenue SW. Other major lines are located along 15<sup>th</sup> Avenue NW, 15<sup>th</sup> and 16<sup>th</sup> Avenues W, Elliott Avenue W, Utah Avenue S, Second and Third Avenues, SW Alaska Street, and SW Andover Street (BERGER/ABAM 2003a,c).
- **Steam.** Seattle Steam, a privately held company operating in agreement with the City, maintains 18 miles of piping in a one-square-mile area of Downtown Seattle. Steam distribution lines within the project area include a 12-inch intermediate pressure line traveling north and south along First Avenue. Steam is pumped through four main boilers with operating pressures of 140 pounds per square inch. Average production in the winter peak season is nearly 500,000 pounds of steam per hour, with a 100-pound-per-hour average in the summer (PSBJ 2001). Within the project area, the primary steam pipes range between eight and 12 inches in size (not including insulation) and are located along Stewart Street and Second Avenue (BERGER/ABAM 2003a,c).
- **Telecommunications/Fiber Optics.** Qwest provides local telephone service in the project vicinity and has fiber-optic lines in the project area. Several private companies and public utilities also own fiber-optic cable and/or provide long-distance and other telecommunication services in the general project area. Fiber-optic lines in the project area are primarily concentrated within the Queen Anne/Seattle Center/Belltown, Downtown, and SODO Segments. Many of the fiber-optic lines utilize deactivated gas pipes for conveyance. The City of Seattle Department of Information Technology (DoIT) also provides telecommunications, telephone, data network capability, and cable management services in the project area. DoIT provides a data network connecting all of the City's 8,000 computers and City departments together and connecting them to the Internet. DoIT also operates and maintains the City's private telephone network (about 12,000 telephones), voicemail, telephone management system, and the City's telecommunications (telephone and data networking) functions (Seattle, City of 2003a).
- **Traffic Signal Optimization Program.** Seattle Department of Transportation (SDOT) operates signals within the Green Line project area and within the Seattle city limits, including over 975 signalized intersections, three quarters of which are on major transportation corridors such as Aurora Avenue N, Delridge Way SW, Rainier Avenue S, and in the entire Downtown area (Seattle, City of 2003). The Signal Optimization Program is a coordinated effort designed to make the most efficient use of our city's traffic signals by improving traffic signals, gathering up-to-date traffic data, and taking advantage of new technologies. Optimization refers to all maintenance, upgrades, timing adjustments, and other efforts to improve signalization (Seattle, City of 2003b).
- **Seattle Center.** The Seattle Center operates a public and private utility system that serves the 74-acre site, which is home to a variety of venues and facilities, including Pacific Northwest Ballet, Key Arena, Seattle Center Monorail, Space Needle, Experience Music Project, Memorial

Stadium, Seattle Children's Theater, and others. The Seattle Center operates a combination of utilities, including power, water, sewer, storm, natural gas, and steam. Telephone, fiber optic, and cable are also located in this area. Both Seattle Center and Qwest own and maintain underground telecommunications in this area, with major lines along Thomas Street, while SPU owns, operates, and maintains the water system serving this site. The utility systems in the Seattle Center Segment are typical of the utilities found in the project area and include power, natural gas, water, sewer, stormwater, steam, and telecommunications/ fiber optic services.

## **4.9.2 Impacts**

### **4.9.2.1 Long-Term System Impacts – Public Services**

Impacts of the Green Line on public services could involve either the physical placement of the project on or adjacent to a public service facility or a change in the operating environment of the public service. In some cases, the location of the project could also affect the level or type of services (such as police or emergency services) that may be provided. Some of the alternatives for Green Line stations, facilities, or guideway alignments could require the acquisition of publicly owned property, but overall acquisitions of such properties are low for all alternatives. Throughout most of the Green Line alignment, the same emergency service providers would respond to a call at any given station or alignment section regardless of the alternative. To the extent that differences among alignment and station alternatives exist that result in different impacts, those impact differences are noted. Further, see Section 4.17-Construction for a discussion of construction impacts and mitigation.

The majority of the differences between alternatives involve location-specific changes in access to or by public services through the placement of Green Line routes or stations and through related roadway changes and transportation conditions. In most cases, the demand for services would be similar among alternatives and the analysis focuses on the relative change from No Action conditions.

In terms of access to public services along the Green Line, analysis indicates that access to some public services could be enhanced because of the Green Line. For example, there are schools within the vicinity of the proposed stations in the Ballard, Queen Anne/Seattle Center/Belltown, and West Seattle Segments of the Green Line project whose students could use the monorail for access. The Green Line could also result in an overall beneficial effect on access to public services by providing enhanced mobility.

Access by public services (specifically response times for some public services such as police, firefighting, and emergency medical aid) may be affected by placement of guideway columns. Impacts would be greater for center alignment alternatives for the guideway because left turn movements may be more difficult or may be prohibited at some intersections, mid-block or driveway access could be restricted to right-in/right-out movements, and because emergency vehicles often use a center left-turn lane as a through travel lane to avoid traffic congestion. Specific recommendations for improving vehicle access and circulation in locations where guideway columns would be provided in an existing center two-way left turn lane are identified in the Transportation Mitigation section (Section 4.1.6). The SMP design team will coordinate with providers to determine the alternative with the least impact to emergency services routes during both construction and operation. In most locations along the project, parallel arterials may provide alternative routes if needed. The exception is in the Interbay Segment, where 15<sup>th</sup> Avenue W and Elliott Avenue W do not always have adjacent parallel routes. For these streets, center alignments would involve comparatively more restrictions than alignments on the west side of the streets. However, provision for u-turns or provision of mountable curbs (so that emergency vehicles could drive over the median beneath the guideways, if necessary) would minimize potential delays or increases to response times (see Section 4.1.6 for additional information).

The potential impact of the Green Line on response times is difficult to quantify because response time is dependent on a large number of variable factors, such as time of day, degree of traffic congestion, types of uses in the neighborhood, extent of construction activity in the neighborhood, and how response time is calculated. Average citywide response times for the Seattle Fire Department fire, rescue, and hazardous material calls, for example, have varied from a low of 4.01 minutes in 1995 to a high of 4.24 minutes in 2002.

Delay of vehicles due to reduction in level of service (LOS) at intersections throughout the project has been analyzed and is discussed in Section 4.1, Transportation (for mitigation of these impacts on Green Line operations, see Section 4.1.6 and for mitigation of construction impacts, see Section 4.17 Construction). The Green Line may result in delay of emergency vehicles due to worsening LOS ratings at the following intersections:

- In the Ballard Segment, both Alternatives 1.1 and 1.2 may result in delays at 15<sup>th</sup> Avenue NW and NW Market Street, and 15<sup>th</sup> Avenue NW and NW 65<sup>th</sup> Street. (Within this segment, the eastbound approach of the 15<sup>th</sup> Avenue NW and Holman Road NW intersection is already operating at an unacceptable LOS during the a.m. peak hour.)
- In the Interbay Segment, both Alternatives 2.1 and 2.2 may result in delays at W Dravus Street and 16<sup>th</sup> Avenue W and the 15<sup>th</sup> Avenue W ramp terminal intersections with W Dravus Street.
- In the Queen Anne/Seattle Center/Belltown Segment, Alternative 3.5 (Second/Denny) may result in delays at Denny Way and Broad Street, particularly in the p.m. peak hour. Alternative 3.5 may also result in delays at Denny Way and Fifth Avenue during the a.m. peak hour.
- In the Downtown Segment, none of the Green Line alignment alternatives would significantly worsen intersection operation.
- In the SODO Segment, intersection LOS is expected to remain the same as the No Action conditions.
- In the West Seattle Segment, the proposed Avalon 1 (Center) station alternative (Alternative 6.1) may result in delays at Fauntleroy Way SW and SW Avalon Way, as well as at 35<sup>th</sup> Avenue SW and SW Avalon Way.

A few of the proposed alternatives may eliminate travel lanes, thereby reducing roadway capacity and potentially increasing emergency response times. Alternatives with streets that may be impacted due to loss of one or more travel lanes could include the following:

- Alternative 1.1 (West Side of 15<sup>th</sup>) in the Ballard Segment would eliminate one southbound travel lane currently open to traffic from 7:00 to 9:00 a.m. on 15<sup>th</sup> Avenue NW between NW 85<sup>th</sup> Street and NW 65<sup>th</sup> Street.
- Alternative 2.2 (Center of 15<sup>th</sup>/West Side of Elliott) in the Interbay Segment would eliminate one southbound travel lane currently open to traffic from 7:00 to 9:00 a.m. on Elliott Avenue W between the Magnolia Bridge and Morrison Street.
- Alternative 3.5 (Second/Denny) in the Queen Anne/Seattle Center/Belltown Segment would eliminate one eastbound travel lane on Denny Way between Second Avenue and Fifth Avenue.
- Alternative 5.1.2 (First Avenue S) in the SODO Segment would eliminate one southbound travel lane currently open to traffic from 4:00 to 6:00 p.m. on First Avenue S between S Lander Street and S Horton Street.
- All Downtown Segment alternatives would also eliminate one lane on Stewart Street.

For center alignments, placement of monorail guideway columns could eliminate center two-way left turn lanes. This could result in reduced left-turn opportunities to and from unsignalized side streets. In locations where guideway columns would be placed in the center of one-way streets, vehicles could be prohibited from passing between columns to change lanes. These vehicular access restrictions could result in some out-of-direction travel for emergency vehicles, which could increase emergency response times. Emergency vehicles could also be affected because some of them currently use center left-turn lanes as through lanes to avoid traffic congestion and travel more quickly during emergency situations.

Placement of guideway columns could eliminate the center two-way left turn lane along the following streets:

- Alternative 1.2 (Center of 15<sup>th</sup>) in the Ballard Segment would eliminate the center turn lane on 15<sup>th</sup> Avenue NW.
- Alternative 2.1 (West Side of 15<sup>th</sup>/Center of Elliott) in the Interbay Segment would eliminate the center turn lane on Elliott Avenue W.
- Alternative 2.2 (Center of 15<sup>th</sup>/West Side of Elliott) in the Interbay Segment would eliminate the center turn lane on 15<sup>th</sup> Avenue W.
- Alternative 6.1 (West Seattle Bridge) in the West Seattle Segment would eliminate the center turn lanes on SW Avalon Way and California Avenue SW.
- Alternative 6.2 (New Bridge) in the West Seattle Segment would eliminate the center turn lanes on SW Avalon Way.

One-way streets potentially affected by placement of guideway columns down the center of the street include:

- Alternatives 3.1 (Seattle Center/Republican), 3.3 (Thomas), and 3.5 (Second/Denny) in the Queen Anne/Seattle Center/Belltown Segment would place guideway columns down the center of Fifth Avenue (in place of existing monorail columns).
- Alternative 4.3 (Center of Second) in the Downtown Segment would place guideway columns down the center of Second Avenue. (These columns would have special straddle foundations underground to avoid conflict with a major underground utility).

Regardless of the alignment alternative, planning to respond to emergencies on Green Line trains, at stations, or along the guideway could place new or different demands on emergency service providers. Emergency services could potentially be required for events such as a medical emergency, fire, or natural disaster at any of the stations, the Operations Center, or along the guideway. The Green Line would be designed to provide a means of exiting a train in the event of an emergency stop and evacuation anywhere on the alignment, allowing passengers to reach a safe haven, either on the ground or at a nearby station. However, special procedures, training, or equipment may be required to address emergency access to trains on the guideway, particularly on the Ship Canal crossing in the Ballard Segment and on the Duwamish River crossing under Alternative 6.2 (New Bridge).

In terms of firefighter access to the monorail guideway and to adjacent buildings during an emergency, the Seattle Fire Department has indicated that (with exceptions in a few areas) ladders could reach over the guideway if needed (Conley 2003). However, it should be noted that ladders would be used to reach the guideway only as a last resort, and only after traction power has been disconnected. Additionally, the guideway itself could compromise firefighter's ability to fully access adjacent buildings with aerial ladders. In these instances, ground-based ladders would be used.



At the Federal Office Building on Second Avenue, Green Line guideways could potentially complicate surveillance and security measures due to reduced visibility from the street because of guideway and station supports and larger numbers of people moving around the entries to the building. Neither the guideway nor the stations in any segment are expected to adversely affect any U.S. Post Office.

Acquisition of public property would be required for some segments. For alignment Alternative 1.2 (Center of 15<sup>th</sup>), a partial acquisition or air rights could be required from the Seattle Central Community College Maritime Training Center. However, it is expected that use of the property by the Maritime Training Center would not be affected. A portion of the property at Fire Station 36 in West Seattle would be acquired for placement of guideway columns for Alternative 6.1.2 (To Pigeon Point). Exact location of columns would be coordinated with Seattle Fire Department to avoid potential impacts. Similarly, Fire Station 32 could be affected by Alternative 6.2 (New Bridge). Station 32 has not been identified as a property acquisition need at this time, but SMP will coordinate with Seattle Fire Department on column placement to avoid impacts to services. Further discussion of the impacts to public properties can be found in Section 4.2, Displacements and Relocation.

In terms of Green Line operations and security at stations, SMP intends to hire security staff to patrol Green Line stations and trains and will develop a security plan for Green Line operations. In addition, incorporating principles of Crime Prevention Through Environmental Design (CPTED), such as strategic lighting, clear sightlines on the station platforms, and overall station site design, could enhance public safety at Green Line stations.

#### **4.9.2.2 Long-Term System Impacts – Utilities**

For construction impacts of utility relocation, please refer to Section 4.17, Construction. The Green Line system has the potential to cause direct and indirect impacts to utility services and infrastructure during operation. Longer-term operational impacts could include the potential for additional power infrastructure to serve the Green Line system, and potential conflicts with existing utility maintenance and replacement operations. See Section 4.17.10.2 for a discussion of utility relocation and utility impacts from construction of Green Line alternative alignments and stations.

This analysis of utility impacts focuses on utilities in close proximity to the Green Line alignment alternatives and provides a relative comparison of the level of impacts that could be expected for the different alignment and station alternatives. The basis for the utility analysis was the BERGER/ABAM overhead and underground utility relocation plans, tables, and cost estimates prepared for SMP, dated June 2003. This documentation is hereby incorporated by reference (BERGER/ABAM 2003a-f) (see Table 4.17-8 in the Construction section for a summary of this information).

Placement of guideway columns could complicate long-term maintenance of underground utilities when the guideway or other structures are in the immediate vicinity of the utility, although utility location will be one factor used to determine column placement. Guideway beams will typically span intersections to avoid cross-section utility impacts. Where foundations might limit access, these will be addressed on a case-by-case basis during final design. However, no significant adverse impacts to natural gas, telephone, telecommunications, water supply, wastewater, drainage, steam, or solid waste collection and disposal services would be expected during operation of the Green Line under any of the alternatives.

Underground gas, water, and sewer lines and other pipes and conduits beneath columns would not likely be affected by the weight of elevated segments because potentially affected utilities would be relocated or otherwise protected before or during construction. Concerns have been expressed that settling of elevated sections could affect underground utilities. However, it is unlikely that any settling would occur because the Green Line must have secure foundations, and foundations would be engineered to ensure that no

settling occurs. Design and construction of foundation systems would not create loads or settlement of utilities or pipes.

As discussed in Section 4.8, Energy, the Green Line would be replacing fossil fuel sources for transportation, but could potentially increase the electricity demand and consumption on the existing electrical system in the project area. Power demand for Green Line operation would not significantly affect City Light's regional capacity, although upgrades to some transmission lines and power substations may be required. Section 4.8 includes a more detailed analysis of power supply and the Green Line's estimated power needs. Primary power would likely be provided to the monorail trains and stations from electrical feeds generated by either the Canal or Delridge substations.

Electrical power to the Green Line system could create the potential for stray current, which could accelerate the corrosion of underground utilities (i.e., buried metal pipes and conduits). Stray current is guideway power rail DC current that has found an alternate path (not through the power rails). Stray current is eliminated through isolation of the power rails and possibly redundant power cabling. Stray current monitoring equipment is part of the guideway power system design and is located in the guideway power stations (SMP 2003c). In addition, design of the elevated guideway system and its structures would have lower potential for stray current compared to an at-grade or underground system, and the Green Line could incorporate cathodic protection devices within the structures and piers/foundations to further minimize the potential for stray current to be transmitted to underground utilities.

#### **4.9.2.3 Impacts of No Action Alternative**

No impacts on public services would occur under the No Action Alternative. However, access to schools (particularly Shine Bright Montessori, St. Alphonsus, and Ballard High School in the Ballard Segment and Center High School in the Queen Anne/Seattle Center/Belltown Segment) could be enhanced with the Green Line compared to the No Action Alternative.

No significant adverse impacts to Seattle utility services or infrastructure would occur under the No Action Alternative.

### **4.9.3 Mitigation**

#### **4.9.3.1 Mitigation of Long-Term Impacts – Public Services**

Because the Green Line would be elevated, it is anticipated to have only minimal impacts to mobility along surface streets other than those specifically noted in Section 4.9.2.1. The Green Line could change access to or from public services, but effective transportation service and circulation could be maintained through provision of left turns at intersections and the ability to make u-turns or circular routes. Increases in emergency services response times could be further minimized through coordination of project design and emergency response route planning, and by the potential for medians to be designed to allow emergency vehicles to cross, or by the provision of u-turns at selected locations. The impact on response times for emergency vehicles could be partially mitigated through the use of intelligent traffic control technology as approved by the Seattle Fire Department and Seattle Department of Transportation. Analysis indicates that the Green Line may improve access to some public services such as to schools along the alignment.

In terms of impacts to public services resulting from increased demand caused by the Green Line itself, SMP intends to prepare a Safety and Security Plan for operations to minimize increased demand on public services. Monorail trains would be designed to minimize the possibility of accidental fire and include a minimal amount of combustible material.

SMP also intends to incorporate principles of Crime Prevention Through Environmental Design into the design of stations and structures to maximize public safety at and around stations. Security personnel and closed-circuit television could be used to provide additional security at stations, particularly at the Seattle Center/Queen Anne, Weller Street, and Safeco Field stations during major events.

Additionally, SMP intends to participate in emergency and security planning with local, regional, and federal authorities to enhance preparedness for a wide range of potential risks, including natural disasters, accidents, and terrorist activities.

SMP is also part of a Fire Safety Committee that includes the Seattle Fire Department, the Seattle Police Department, and other City of Seattle representatives. This standing committee would address fire and life safety issues throughout the project.

Emergency egress walkways are planned along the guideway to provide for safe evacuation in the event of an emergency. The Fire Safety Committee would review the design of the walkways, including access to and from them. Special procedures may need to be developed and could be reviewed by the Fire Safety Committee and included in the Safety and Security Plan to ensure the safety of firefighters and Green Line passengers in the event of a fire.

#### **4.9.3.2 Mitigation of Long-Term Impacts – Utilities**

Green Line operation is expected to cause minimal impacts to utilities over the long term based on the design aspects of the system, and in part, compliance with:

- City of Seattle and Washington State energy, building, fire, and other applicable code requirements for all design aspects of Green Line systems, stations, Operations Center, and guideways.
- Relevant operational utility policies and strategies listed in the adopted City of Seattle Comprehensive Plan, Utilities Element (level of service, conservation strategies, and coordination of service providers).

See Section 4.17.10.2 for a discussion of construction impact mitigation on Utilities.

#### **4.9.4 Significant Unavoidable Adverse Impacts**

The mitigation measures described above are expected to address any impacts on public services and utilities that could occur as a result of operation of the Green Line. Therefore, no significant unavoidable adverse impacts are expected.

## 4.10 PARKS AND RECREATION

### 4.10.1 Affected Environment

Seattle's parks and recreation system consists of open spaces, parks, boulevards, trails, beaches, lakes, and streams; recreational, cultural, environmental, and educational facilities; and a broad variety of programs. The diverse system is woven into the fabric of Seattle neighborhoods and contributes to the city's identity, stability, urban design, and network of public services. Citywide, the Seattle Parks and Recreation Department administers 400 parks and open space areas covering approximately 6,200 acres.

There are twenty existing and twelve planned parks and recreational facilities that are under the jurisdiction of City of Seattle Parks and Recreation Department and are within 600 feet of Green Line guideway alignment, station, and Operations Center alternatives (Seattle Parks and Recreation Department 2002). Tables 4.10-1 and 4.10-2 list existing and planned park and recreational resources, respectively, identified within the proximity of the Green Line project area. Existing parks are discussed in more detail in the following sections. The Seattle Center is not a City of Seattle park property and therefore it is not listed in these tables. Figure 4.10-1 shows the existing park and recreational resources.

**Table 4.10-1. Existing Parks and Recreational Resources Within 600 Feet of the Green Line Alignment Alternatives**

Segment	Park Resource
Ballard	Baker Park on Crown Hill
	Ballard Swimming Pool
	Greg's Garden (East Ballard P-Patch)
	14 <sup>th</sup> Avenue NW Boat Ramp
Interbay	Interbay Athletic Complex
	Interbay P-Patch
	Southwest Queen Anne Greenbelt
	Kinnear Park
Queen Anne/Seattle Center/Belltown*	Tilikum Place
Downtown	Westlake Park
	Pioneer Square Park
	Occidental Square
SODO	Union Station Square
West Seattle	West Duwamish and Pigeon Point Greenbelt
	Longfellow Creek Greenspace
	West Seattle Stadium Park
	West Seattle Golf Course
	Camp Long
	Fauntleroy Place
	Eddy Street Ravine

\* Seattle Center is not a City of Seattle Parks and Recreation Department park, so it is not included in this list.

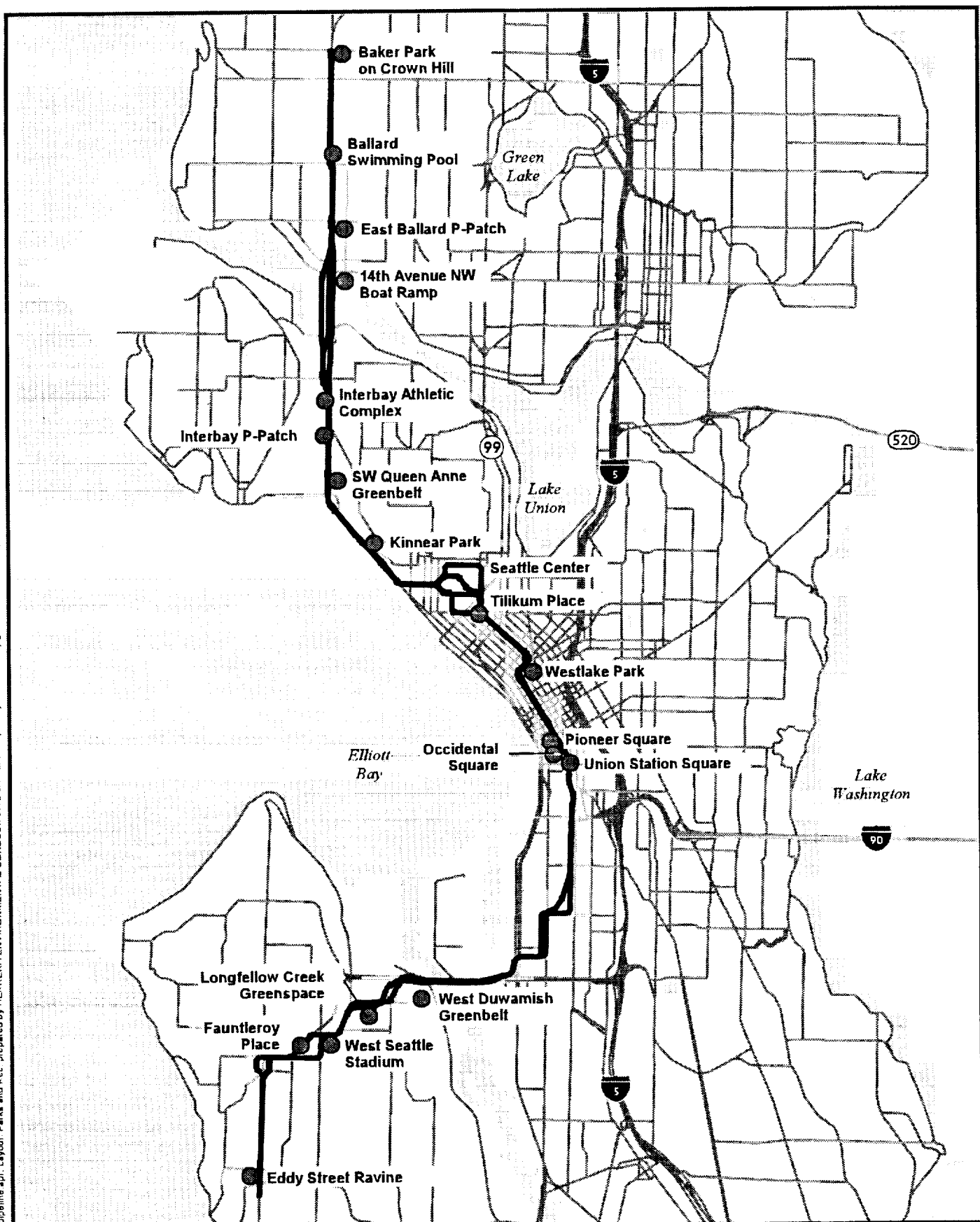
Source: *Seattle Park Guide*, Seattle Parks and Recreation (2001).

**Table 4.10-2. Major Park Projects Planned Near the Green Line Alignment Alternatives**

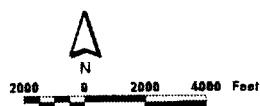
Segment	Planned Park Project	Implementation Status
Ballard	Development of the Ballard Municipal Center park at 5701 22 <sup>nd</sup> Avenue NW in conjunction with the proposed Ballard Municipal Center development	Planning is scheduled in 2005–2008 funding cycle
	Development of Monroe Substation site at NW 65 <sup>th</sup> Street and 15 <sup>th</sup> Avenue NW into a small park, possibly a community garden	Seattle Parks expect to purchase property from Seattle City Light in 2004
	Extension of the Burke-Gilman Trail (the missing link) from Fremont through an alignment south of NW Market Street	Section from the Ballard Locks to NW 60 <sup>th</sup> Street is scheduled for construction in 2003; design study has been completed for the “missing link” segment between 11 <sup>th</sup> Avenue NW and the Ballard Locks
	Recently purchased pocket park site at southwest corner of NW 63 <sup>rd</sup> Street and 17 <sup>th</sup> Avenue NW	Property was purchased by Seattle Parks on March 17, 2003 and planning is underway
Interbay	No new parks are planned for the Interbay Segment at this time	
Queen Anne/ Seattle Center/ Belltown	Development of Belltown/Uptown waterfront connections to Myrtle Edwards Park	No schedule information is available
	Development of Ward Springs Park (Fourth Avenue N and Ward Street)	Park opened on June 1, 2002
Downtown	No new parks are planned for the Downtown Segment at this time	
SODO	No new parks are planned for the SODO Segment at this time	
West Seattle	Purchase of surplus utility property (California Substation) for park	Planning process scheduled to begin in September 2003
	Acquisition of Seattle City Light's Morgan Substation on Fauntleroy Way to develop a small park/plaza	Planning is scheduled in 2005–2008 funding cycle
	Purchase of land along Longfellow Creek and Puget Ridge for Delridge open space	Funding is available to build or improve trail segments in 2003–2004
	Walking trail development along Longfellow Creek Legacy Trail	Project completed during early 2003
	Link between Alki Trail and Spokane Street Trail	No schedule information is available
	Planned “Junction Square” plaza on northwest corner of SW Alaska and 42 <sup>nd</sup> Avenue SW	No schedule information is available

Source: ETC (2002).

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SEATTLE MONORAIL PROJECT



● Parks, Recreational Resources, and P-Patches

— Green Line Alignment Alternative

**Figure 4.10-1 Locations of Parks, Recreational Resources, and P-Patches along the Green Line Corridor**

#### **4.10.1.1 Segment 1: Ballard Segment**

The Ballard Segment has four existing and four planned parks (Table 4.10-2) and recreational resources within 600 feet of the Green Line alignment alternatives. Existing parks and recreational resources include:

- **Baker Park on Crown Hill.** This 0.4-acre park includes a small play area, a pedestrian path, and a totem pole made from a monkey-puzzle tree. Baker Park spans the block between Mary Avenue NW and 14<sup>th</sup> Avenue NW, one lot south of NW 85<sup>th</sup> Street. Adjacent uses include residences and commercial properties.
- **Ballard Swimming Pool.** This is an indoor facility open for public use throughout the week. The pool is located on the east side of 15<sup>th</sup> Avenue NW immediately south of NW 67<sup>th</sup> Street and north of Ballard High School.
- **Greg's Garden.** This was formerly known as the East Ballard P-Patch. It covers 5,000 square feet is located on the southwest corner of 14<sup>th</sup> Avenue NW and NW 54<sup>th</sup> Street.
- **14<sup>th</sup> Avenue NW Boat Ramp.** The 0.64-acre boat ramp is located on the Lake Washington Ship Canal at the intersection of 14<sup>th</sup> Avenue NW and Shilshole Avenue NW, east of the Ballard Bridge. The site is one of Seattle's free-of-charge boat launch ramps, offering two piers and two launch lanes. The boat ramp was renovated in 1996, adding a new dock, a resurfaced ramp, and improved parking. The upland improvements include two handicap parking stalls and an accessible portable restroom.

#### **4.10.1.2 Segment 2: Interbay Segment**

The Interbay Segment has four existing parks and recreational resources within 600 feet of the Green Line alternative alignments. Existing parks and recreational resources include:

- **Interbay Athletic Complex.** The Interbay Athletic Complex includes the Soccer Center, the 39-acre, nine-hole Interbay Golf Center, and Little League baseball, softball, and T-ball facilities. It is west of 15<sup>th</sup> Avenue W between W Dravus and W Wheeler Streets.
- **Interbay P-Patch.** The 1.91-acre P-Patch is a year-round, community-operated garden located at the southeast end of the Interbay Athletic Complex, on 15<sup>th</sup> Avenue W just north of W Wheeler Street.
- **Southwest Queen Anne Greenbelt and Kinnear Park.** The approximately 15-acre Southwest Queen Anne Greenbelt and the two-tiered 14-acre Kinnear Park are located on the southwest slope of Queen Anne Hill above 15<sup>th</sup> Avenue W and Elliott Avenue W. The parks offer views of Elliott Bay and Downtown Seattle, walking paths, and wooded areas and grassy areas for sitting.

#### **4.10.1.3 Segment 3: Queen Anne/Seattle Center/Belltown Segment**

This segment has one existing park and two planned park improvements (Table 4.10-2) within 600 feet of the Green Line alternative alignments. The existing park is:

- **Tilikum Place.** This 0.1-acre park is located in Belltown at the "five points" intersection of Fifth Avenue, Denny Way, and Cedar Street, immediately west of the existing monorail. The park has the life-size statue of Chief Seattle made by James Wehn in 1912.

Seattle Center is a 74-acre recreational and cultural facility located between lower Queen Anne and Belltown. It is an important recreational and cultural resource for the city. However, since Seattle Center

is not a City of Seattle park, it is not discussed in this chapter, but, instead, is discussed extensively in Section 4.3, Land Use and Neighborhoods, and Section 4.5, Visual Quality and Aesthetic Resources.

#### **4.10.1.4 Segment 4: Downtown Segment**

The Downtown Segment contains three existing parks within 600 feet of the Green Line alternative alignments. There are no planned park projects.

- **Westlake Park.** Westlake Park is located in the heart of Seattle's retail district on Pike Street between Fourth and Fifth Avenues.
- **Pioneer Square Park.** Pioneer Square Park is located at First Avenue and Yesler Way in the Pioneer Square Historic District and contains the Pioneer Square Pergola.
- **Occidental Square.** Occidental Square is located at Occidental Avenue S and S Main Street in the heart of Pioneer Square and contains the Firefighter's Memorial.

The Garden of Remembrance at Benaroya Hall is not a city park, but is a public resource. It is discussed in Section 4.5, Visual Quality and Aesthetic Resources.

#### **4.10.1.5 Segment 5: SODO Segment**

The SODO segment has one existing park resource. No park projects are planned for this area. Safeco Field and Seahawks Stadium are spectator sport recreation facilities that would be served by the Green Line, and are noted as such in Section 4.3, Land Use and Neighborhoods.

- **Union Station Square.** This triangular property is in the Pioneer Square District at S Jackson Street between Second and Third Avenues S. The park does not have active uses.

There are also two public parks on the Green Line that are under the Seattle Department of Transportation's jurisdiction: Fortson Square on the southeast corner of Yesler Way and Second Avenue S, and Washington Square on the southwest corner of S Jackson Street and Second Avenue Extension S.

#### **4.10.1.6 Segment 6: West Seattle Segment**

The West Seattle Segment has six existing parks, one city-owned open space area (Eddy Street Ravine), and six planned park improvements (Table 4.10-2) within 200 feet of the Green Line project area. Existing parks and recreational resources include:

- **West Duwamish and Pigeon Point Greenbelt.** A portion of the 181.6-acre West Duwamish Greenbelt is located within the West Seattle Segment and includes a steep slope area at Pigeon Point. The greenbelt is owned by the City of Seattle and is composed of steep, wooded slopes above the West Seattle Bridge and the east-facing slopes above W Marginal Way and the Duwamish River.
- **Longfellow Creek Greenspace.** Longfellow Creek originates in Roxhill Park to the south and flows north about four miles parallel to the Delridge Way SW corridor. The creek enters a pipe at SW Andover Street that carries the stream under the Nucor Steel property and discharges into the West Duwamish Waterway to the northeast. The Longfellow Creek watershed is approximately 2,685 acres, and the Longfellow Creek Greenspace is managed so as to preserve and protect the stream. The greenspace is largely undeveloped, although there are footpaths used by the public, including residents in the neighborhood. There has been a community effort to improve the stream for fish habitat for several years, including yearly fish releases conducted by local schools. A Longfellow Creek Dragonfly Pavilion is planned to be located near the SW Yancy Street creek



and buffer area. The plant and animal environment of Longfellow Creek is described in more detail in Section 4.15, Plants and Animals.

- **West Seattle Stadium Park.** This park has football and soccer fields and facilities for field sports (such as long jump, pole vault, shot put, and others), including a 400-meter track. The fields are used for youth, masters, and high school meets.
- **West Seattle Golf Course.** This is a public 18-hole golf course.
- **Camp Long.** This 68-acre park has a nature center with meeting and recreational facilities for environmental education, forested trails and paths for hiking, cabins and picnic shelters, a climbing rock, and a pond.
- **Fauntleroy Place.** Fauntleroy Place is a triangular landscaped area (0.07-acre) at the junction of Fauntleroy Way SW, 38<sup>th</sup> Avenue SW, and SW Oregon Street. It is used primarily as a bus stop waiting area.
- **Eddy Street Ravine.** Eddy Street Ravine is a public street right-of-way and City-owned open space located west of California Avenue SW to 47<sup>th</sup> Avenue SW along the curve of SW Eddy Street. This ravine is one of the largest unimproved open spaces in the Morgan Junction area, with opportunities for trails, native habitat restoration, and interpretive signing.

#### **4.10.2 Impacts**

##### **4.10.2.1 Long-Term Impacts**

Direct long-term impacts from the Green Line could include view blockage, shadows, and access restrictions where parks or recreational resources are located adjacent to the monorail guideway or a station. Increased traffic or transit activity near a park or recreational resource could also cause changes in access, shadows, and views from parks. Shadow and view impacts are also discussed in Section 4.5, Visual Quality and Aesthetic Resources. Increased noise is not expected to be high, unless otherwise specified in the discussion below, due to the urban setting.

Operation of the Green Line could improve access to parks and recreational resources, especially for those who live or work within walking distance of a monorail station, which could increase park usage without increasing parking demand.

Potential long-term impacts on parks and recreational resources in each segment of the Green Line are discussed below.

#### **Segment 1: Ballard Segment**

Green Line station and alignment alternatives are expected to have low impacts on parks along the alignment in Ballard.

- **Baker Park on Crown Hill.** Views of the Green Line station and guideway Alternatives 1.1 and 1.2 would be blocked by the Crown Hill Safeway at NW 85<sup>th</sup> Street and 15<sup>th</sup> Avenue NW. Project impacts to this park are expected to be low for both alignments and station alternatives.
- **Ballard Swimming Pool.** The NW 65<sup>th</sup> 2 (Center) station alternative would have a moderate to high impact on the Ballard Swimming Pool because of the platform and access stairs on the east side of 15<sup>th</sup> Avenue NW, directly adjacent to the pool building. Impacts would include a change in visual character and possible removal of street trees. Shadow impacts on the building and parking lot would be low since the corner and west side of the building are now shaded by

medium to very large trees. Access to the pool and the planned park at the Monroe Substation site could improve with the addition of the Green Line, which could increase use of the pool. Station alternative NW 65<sup>th</sup> 1 (West) would have no direct impact on the pool because it would be located south of NW 65<sup>th</sup> Street. With either alternative, there would be potential parking impacts. These would be expected to be greater with NW 65<sup>th</sup> 2 because of its close proximity.

- **Greg's Garden and 14<sup>th</sup> Avenue NW Boat Ramp.** Operational impacts on Greg's Garden and the 14<sup>th</sup> Avenue NW Boat Ramp are expected to be low to nonexistent for all three Ship Canal bridge alternatives (1.2, 1.1.1, and 1.1.2) because the alternatives would be approximately 600, 1,000, and 1,800 feet away from the 14<sup>th</sup> Avenue NW Boat Ramp, respectively, and 600 feet from Greg's Garden. Impacts on the planned extension of the Burke-Gilman Trail due to any of the alignment or station alternatives are expected to be low because the trail would be passing through an industrial corridor in this area.

## **Segment 2: Interbay Segment**

Green Line station and alignment alternatives are expected to have low to moderate impacts on parks along the alignments in Interbay. Alignment Alternative 2.2, traveling along the west side of Elliott Avenue W, would be adjacent to the perimeter of the Interbay Athletic Complex and Interbay P-Patch. Golf course and P-Patch users in particular could experience changes to the visual or aesthetic setting and altered access due to the location of the guideway and columns. Alignment Alternative 2.1 is expected to have less impact than Alternative 2.2 because Alternative 2.1 would be in the center of Elliott Avenue W, an additional 50 feet farther away. Access to these park and recreational areas may improve due to the increased transit service frequency with any of the alternatives, which may increase use of these park resources.

The Interbay Operations Center alternative is located on the Northwest Center site, immediately south of the Interbay P-Patch. Long-term noise, traffic, or visual impacts associated with the Operations Center are expected to be low given the low-intensity nature of the uses and low number of personnel required at the Center. There would be no operational impacts on the Southwest Queen Anne Greenbelt and Kinnear Park because of their locations above and east of 15<sup>th</sup> Avenue W.

## **Segment 3: Queen Anne/Seattle Center/Belltown Segment**

Impacts on Tilikum Place under Alternatives 3.1, 3.3, or 3.5 would be lower than impacts associated with the No Action Alternative because of newer and quieter trains compared to the existing monorail. Green Line columns and guideway would also be less bulky and therefore less of a presence than the existing monorail. An increase in visual obstruction could be expected from Alternative 3.2 (Mercer) if the existing Seattle Center Monorail remains along with the Green Line. Impacts to Seattle Center are discussed in Section 4.3, Land Use and Neighborhoods, and Section 4.5, Visual Quality and Aesthetic Resources. There would be no impacts on the planned parks.

## **Segment 4: Downtown Segment**

Green Line alternatives are expected to have no or low impact on the Downtown parks.

- **Westlake Park.** The monorail guideway and stations at Stewart Street would not be visible from Westlake Park. If an elevated pedestrian connection from the Stewart station to Westlake Center is constructed, access to the park could be enhanced. The Fifth and Stewart 1 (Northwest) station alternative could provide greater accessibility to Westlake Park than the Fifth and Stewart 2 (Virginia) or Fifth and Stewart 3 (Lenora) stations, but otherwise the relationship of the park to the station alternatives would be similar.

- **Pioneer Square Park.** No direct impacts are anticipated, although the park could experience moderate vicinity impact. The alignment and Yesler station alternatives would be visible from Pioneer Square Park; however, Pioneer Square Park is a half block from the Yesler station alternatives. Traffic, noise, and activity levels in this park are not expected to increase significantly. Removal of the adjacent Sinking Ship parking garage and the development of a station facility on the site could enhance the park's surroundings and access to the park. Changes to the historic character of the area are discussed in more detail in Section 4.11, Cultural Resources.
- **Occidental Square.** The alternative alignments and stations at Yesler Way and S Weller Streets would be visible from the north half of the park. Traffic, noise, and activity levels in this park are not expected to increase significantly.

### Segment 5: SODO Segment

All of the alignment alternatives would be adjacent to Union Station Square and would introduce a new visual element to the park's surroundings. The guideways could cause some shadows and view blockages; however, overall noise and visual impacts are expected to be low since the park is currently surrounded by transportation uses.

Impacts to Fortson Square and Washington Square could result from a change in visual character and an increase in shading.

### Segment 6: West Seattle Segment

Impacts to the parks in the West Seattle Segment would vary depending on the specific alignment alternative chosen. Impacts to most parks would be low to moderate; however, the Avalon 2 (35<sup>th</sup>) station would be partially sited on park property, a moderate to high impact.

- **West Duwamish and Pigeon Point Greenbelt.** Impacts to the greenbelt would result from alignment Alternative 6.1.2 (to Pigeon Point) due to the placement of piers and other structural supports on steep slopes within Pigeon Point. Trees and other vegetation would likely have to be removed or trimmed to keep the canopies away from the guideways. A discussion of the potential impacts to vegetation and habitat is provided in Section 4.15, Plants and Animals. There could be a low to moderate increase in shading, depending on the slope and existing tree heights at specific locations.
- **Longfellow Creek Greenspace.** Operation of any of the Green Line station and guideway alternatives would introduce an additional visual element for users of the Longfellow Creek Greenspace. Both Delridge station alternatives are located at the north end of the Longfellow Creek Greenspace where the creek enters a culvert to pass under the Nucor Steel plant. Both station alternatives and alignment Alternative 6.1 (West Seattle Bridge) could have columns in the buffer and culvert inflow area. Impacts could be higher for Delridge 1 (26<sup>th</sup>) (Alternative 6.1) if the property to the south of the station and SW Yancy Street is developed as a bus layover facility. Impacts for both alternatives would include shading of the northeast corner of the buffer and could involve the removal of riparian vegetation and a few trees. These station alternatives would be near the future Dragonfly Pavilion, to be located near the curvilinear concrete retaining walls to the southwest. Users of the greenspace park may also experience increased traffic or transit activity, including increased noise from buses and monorail trains. Diffuse shadows would be present from the guideways.
- **West Seattle Stadium Park.** Alternative 6.2 (New Bridge) would travel along 35<sup>th</sup> Avenue SW adjacent to a portion of the park. The Avalon 2 station alternative, located on the east side of 35<sup>th</sup>

Avenue SW at SW Oregon Street, would be located on a sloped, wooded area in a portion of the West Seattle Stadium Park property that is currently used for passive recreation and tree buffer (see Section 4.2, Displacements and Relocation). Trees would be removed from this tree screen/buffer, which could affect the stadium site since the wooded hillside provides a backdrop to the field events at the stadium.

Both the Avalon 1 and Avalon 2 station alternatives may improve access to the West Seattle Stadium, especially for those who live or work within walking distance of the monorail stations.

- **West Seattle Golf Course.** There would be no direct impacts to the golf course because the SW Avalon Way portion of the alignment is not adjacent to the course.
- **Camp Long.** There would be no direct impacts because neither of the alternatives passes by the park.
- **Fauntleroy Place.** Impacts to Fauntleroy Place are expected to be low since the park is located adjacent to a high-volume arterial street (Fauntleroy Way SW). Alternative 6.1.4 (Northwest Side of Fauntleroy) is expected to have less impact than Alternative 6.1.3 (Southeast Side of Fauntleroy) since the Green Line alignment would be farther away from the park across Fauntleroy Way SW. Potential impacts due to either alternative include increased traffic or transit activity, alteration of the visual or aesthetic setting, and some shadow effects. Alternative 6.2 would not impact this park since the alignment would be located on 35<sup>th</sup> Avenue SW.
- **Eddy Street Ravine.** Impacts to the Eddy Street Ravine open space are expected to be low for either Alternative 6.1 or 6.2. However, impacts would be comparatively higher for Alternative 6.1 because the Morgan Junction 1 (West) station site is located just south of the Eddy Street right-of-way. Vehicular access to a short-term parking area and a small staff parking lot would be provided from the end of the Eddy Street right-of-way with Alternative 6.1.

#### **4.10.2.2 Impacts of No Action Alternative**

Adverse impacts on parks and recreational resources would not occur under the No Action Alternative. Access would remain unchanged and growth in resource use would continue, although possibly at a lower rate than with the Green Line project. To the extent that stations are planned near park resources such as the Ballard Swimming Pool, Westlake Park, and West Seattle Stadium, then enhanced access to those resources would not occur with No Action.

#### **4.10.3 Mitigation**

Compliance with Seattle Ordinance 118477 would mitigate impacts of the Avalon 2 (35<sup>th</sup>) station alternative by providing replacement property to restore the park functions that would be lost. Visual impacts as a result of the construction of alignment Alternative 6.1.2 to Pigeon Point and Alternative 6.1 to the Longfellow Creek Greenspace could potentially be mitigated by replanting in those locations after construction or by providing additional plantings at another location, although some visual impact to the Pigeon Point area from this alignment alternative could be unavoidable. During construction, temporary erosion and sediment control practices would be required and implemented. Visual impacts to parks within sight of station alternatives such as West Seattle Stadium Park (Avalon 2), Ballard Swimming Pool (NW 65<sup>th</sup> 2), Pioneer Square Park (Yesler 1 and 2), and Longfellow Creek Greenspace (Delridge 1 and 2) could be mitigated through appropriate design of facilities, including landscaping, special signage, lighting, and access. If the Avalon 2 station alternative is selected, it would be designed to incorporate specific mitigation features for the park, including planting, access improvements, and design features to ensure that use of the stadium is not compromised. If this alternative station site is developed, City of

Seattle Ordinance 118477 would require SMP to replace park property with other property in the same neighborhood that provided equivalent park functions.

The Homeland Security Act of 2002 transferred the U. S. Coast Guard from the U. S. Department of Transportation (DOT) to the U. S. Department of Homeland Security (DHS). Prior to passage of the Homeland Security Act, the Coast Guard's bridge permit program had been a DOT program. As a DOT agency, the Coast Guard was responsible for implementing Section 4(f) of the DOT Act of 1966, which requires DOT agencies to perform a particular type of alternatives analysis for transportation projects that use any land from a public park, recreation area, wildlife and waterfowl refuge, or any historic site. Since the Coast Guard is no longer a DOT agency, a Section 4(f) analysis is not required for Coast Guard bridge permit actions. The Coast Guard will, nevertheless, ensure project environmental impacts on these resources are identified and assessed in the EIS, and appropriately considered before any final agency action on the project is taken.

#### **4.10.4 Significant Unavoidable Adverse Impacts**

Construction and operation of the station at Longfellow Creek Greenspace would result in changes to the visual character and vegetation of the creek buffer at this location that could be perceived as a significant unavoidable adverse impact by park users. Mitigation could provide some improvement over existing conditions, including planting and access improvements.

Similarly, construction of the guideway at Pigeon Point would result in changes to the visual character and vegetation of the greenbelt that could be perceived as an adverse impact by residents near the greenbelt. Mitigation would provide some revegetation and infill planting for the greenbelt.

#### **4.11 CULTURAL RESOURCES**

This section of the EIS reviews the Green Line's potential impacts on cultural resources (archaeological, ethnographic, and historic) under federal, state, and local regulations. Because the U. S. Coast Guard review for water crossings is a federal undertaking, federal regulations under the National Historic Preservation Act (NHPA) apply. State of Washington and City of Seattle regulations regarding cultural resources also apply to the Green Line.

This EIS has been structured to meet the requirements of NEPA, the NHPA, EPA, RCW 27.53, and the City of Seattle Historic Preservation ordinance. There is a difference in terms used to describe the consequences of an alternative under applicable regulations. While NEPA and SEPA documents typically use "impact," NHPA compliance processes involve a determination of effects, and an "adverse effect" is considered a significant impact.

##### **Federal Regulations**

NEPA requires consideration of the effects of an undertaking on cultural resources before an undertaking is approved. 36 CFR Part 800 allows for NEPA/Section 106 consideration. As a result, this EIS has been structured to comply with NHPA in addition to NEPA.

Section 106 of the NHPA of 1966 (as amended) requires federal agencies to assess effects of all federal undertakings (or federally regulated undertakings such as the Green Line), as defined in 36 CFR 800.16(Y) on historic properties. The NHPA defines historic properties as "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on the National Register of Historic Places" (NRHP) (36 CFR 800.16).

The NRHP is the federal list of historic, archaeological, and other cultural resources that are significant in American history, prehistory, architecture, archaeology, engineering, and culture and includes districts, sites, buildings, structures, objects, and landscapes. The list includes not just historic properties themselves, but also artifacts, records, and remains that are related to and located in such properties. Eligibility for inclusion in the NRHP is based on properties that illustrate integrity of location, design, setting, material, workmanship, feeling, and association, and that:

- Are associated with events that have made a significant contribution to the broad patterns of our history; or
- Are associated with the lives of persons significant in our past; or
- Embody the distinctive characteristics of a type, period, or method of construction, represent the work of a master, possess high artistic values, or represent a significant and distinguishable entity whose components lack individual distinction; or
- Have yielded, or may be likely to yield, information important in prehistory or history.

Buildings less than 50 years old do not meet the NRHP criteria unless they are of exceptional importance.

The Homeland Security Act of 2002 transferred the U. S. Coast Guard from the U. S. Department of Transportation (DOT) to the U. S. Department of Homeland Security (DHS). Prior to passage of the Homeland Security Act, the Coast Guard's bridge permit program had been a DOT program. As a DOT agency, the Coast Guard was responsible for implementing Section 4(f) of the DOT Act of 1966, which requires DOT agencies to perform a particular type of alternatives analysis for transportation projects that use any land from a public park, recreation area, wildlife and waterfowl refuge, or any historic site. Since the Coast Guard is no longer a DOT agency, a Section 4(f) analysis is not required for Coast Guard bridge permit actions. The Coast Guard will, nevertheless, ensure project environmental impacts on these

resources are identified and assessed in the EIS, and appropriately considered before any final agency action on the project is taken.

### **Washington State Regulations**

Washington's SEPA Act (RCW 43.21C) and implementing rules contained in the Washington Administrative Code (WAC 197-11) require the identification of historic, archaeological, and cultural resources listed on or eligible for the national, state, or local registers. Measures must be considered to reduce or control effects to identified historic properties affected by a proposed undertaking. In addition, Washington's Archaeological Sites and Resources law (RCW 27.53) provides for the conservation, preservation, and protection of the state's archaeological resources and prohibits individuals, corporations, and agencies from knowingly removing, altering, digging into, excavating, damaging, defacing, or destroying any historic or prehistoric archaeological site without a written permit from the Washington State Department of Community Development or other designee.

The Office of Archaeology and Historic Preservation (OAHP) in Olympia administers Washington State's cultural resources regulations and its NRHP program under the direction of the State Historic Preservation Officer (SHPO). The OAHP also administers the Washington Heritage Register, a Washington-specific list of properties similar to the NRHP.

Federal agencies (including agencies reviewing permits for federally regulated undertakings such as the Green Line project) must coordinate with the SHPO and obtain the review and comment of the Advisory Council for Historic Preservation (ACHP) before beginning undertakings that may affect properties eligible for the NRHP.

### **City of Seattle Regulations**

In adopting its SEPA rules, the City of Seattle established additional environmental policies and procedures specific to historical resources (SMC 25.05). In addition, under the City's Landmarks Preservation Ordinance (SMC 25.12), an object, site, or improvement that is more than 25 years old may be designated for preservation as a landmark if it has significant character, interest, or value as part of the development, heritage, or cultural characteristics of the city, state, or nation, and if it falls into one of the following categories:

- A. It is in the location of, or is associated in a significant way with, any historic event with a significant effect upon the community, city, state, or nation; or
- B. It is associated in a significant way with the life of a person important in the history of the city, state, or nation; or
- C. It is associated in a significant way with a significant aspect of the cultural, political, or economic heritage of the community, city, state, or nation; or
- D. It embodies the distinctive visible characteristics of an architectural style, period, or of a method of construction; or
- E. It is any outstanding work of a designer or builder; or
- F. Because of prominence of spatial location, contrasts of siting, age, or scale, it is an easily identifiable visual feature of its neighborhood or the city and contributes to the distinctive quality or identity of such neighborhood or the city.

The Seattle Landmarks Preservation Board reviews and acts on nominations, designations, and applications or Certificates of Approval (required for any change of use and to alter, demolish, construct,

remodel, or to make visible change to the exterior appearance) for designated features of City landmarks. Properties that are proposed for demolition will be referred to the Seattle Landmarks Preservation Board for consideration as City landmarks.

The City may require reasonable mitigation measures to permitted undertakings when a site of archaeological significance is affected by an undertaking or when a proposed undertaking is located adjacent to or across the street from a designated City landmark. The City's Department of Construction and Land Use Director's Rule 2-98 also applies.

#### **4.11.1 Affected Environment**

##### **4.11.1.1 Area of Potential Effects**

The Green Line is a linear system that will, by necessity, cross many areas where there are numerous cultural resources. The first consideration of the effects of a proposed undertaking on cultural resources is based on determining an Area of Potential Effects (APE). The APE includes "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist. The APE for an undertaking may be different for different kinds of effects caused by the undertaking." This EIS defines APEs for the evaluation of cultural resources along the Green Line. In addition, because of the presence of historic districts in several segments, and based on consultation with the SHPO and the City of Seattle Historic Preservation Officer, the APE for historical resources has been expanded as noted below.

#### **Archaeological Resources**

The Green Line's APE for archaeological resources consists of areas of potential ground disturbance where columns, stations, and substations could be constructed. The APE includes possible historic period archaeological deposits associated with Pioneer Square Historic District areaways below the margins of Second Avenue. The archaeological deposits would be below architectural features that occur within the areaways.

#### **Historical Resources**

In the Ballard, Interbay, SODO, and West Seattle Segments, the Green Line's APE for buildings and structures over 50 years old (historical resources) includes resources adjacent to (within 100 feet of, which encompasses the width of approximately one building) the guideways and stations. These areas consist of mixed residential and commercial use areas that have in-fill development and numerous alterations to resources that are 50 years of age and older.

Within the Downtown and Queen Anne/Seattle Center/Belltown Segments, the APE was expanded to include resources within 200 feet of alternative station locations, due to the presence of historic districts and the density of unaltered historical resources. Similar to the other segments, the APE along guideways in the Downtown and Queen Anne/Seattle Center/Belltown Segments includes areas adjacent to (within 100 feet of) the guideway.

The alternative alignments being evaluated for the Green Line in the Downtown Segment pass through the east side of the Pioneer Square Historic District and within two blocks of the Pike Place Market Historic District.

- **Pioneer Square.** Within the Pioneer Square Historic District, the APE extends 200 feet on either side (east and west) of the guideway at the intersections of Second Avenue and Columbia Street, Cherry Street, James Street, Jefferson Street, Yesler Way, S Washington Street, S Main Street, and S Jackson Street. Only the buildings and structures adjacent to the street in the above-listed



areas are included in the APE. Some of the resources in the specified areas along Cherry Street and all of the resources along Columbia Street are outside the Pioneer Square Historic District boundaries, but are included in the APE due to their age and proximity to the District.

New construction in the Pioneer Square Historic District, including construction in rights-of-way, is subject to certificate of approval review by the Seattle Department of Neighborhoods. The guidelines utilized for this review are designed to help ensure visual compatibility of new structures.

- **Pike Place Market.** In the vicinity of the Pike Place Market Historic District, the APE extends from Second Avenue and Pike Street west along Pike Street and from Second Avenue and Pine Street west along Pine Street, two blocks to the boundaries of the historic district. The APE is expanded in this area to include assessment of visual effects to the Pike Place Market Historic District.

Green Line guideway and columns will be constructed primarily within the public right-of-way, with stations and other facilities located on nearby property. The APE for historical resources reflects the potential for direct and indirect effects to historic resources, either by direct alteration or removal of a historic structure, placement of a modern structure in close proximity to historical resources (Figure 4.11-1), or changing other significant elements of their setting.

#### **4.11.2 Methodology**

**Archaeological and Cultural Resources.** SMP assessed archaeological and traditional cultural places through archival review, archaeological field reconnaissance of a portion of the Pioneer Square Historic District, and consultation with the Duwamish Tribe, the Muckleshoot Indian Tribe, the Suquamish Tribe, and the Tulalip Tribe. Letters of correspondence with the tribes are included in Appendix N, the Section 106 Cultural Resources Report. An archaeological survey of areaways beneath Second Avenue within the Pioneer Square Historic District was conducted to determine if intact archaeological deposits occurred in the lowest story of pre-1889 buildings, several feet beneath contemporary sidewalks. The Sinking Ship Areaway Site (45KI685), a historic period archaeological site, was recorded on the south side of Second Avenue in the Downtown Segment adjacent to proposed Green Line alignment alternatives.

**Historical Resources.** SMP identified significant buildings and structures within the Green Line APE that are 50 years of age (resources). In accordance with Seattle's SEPA rules, the significance of noteworthy resources over 25 years of age was also reviewed. Resources were recorded under the following categories:

- Category A** Significant resources (previously listed in the NRHP, Washington Heritage Register, Seattle Landmarks, or determined eligible for listing in the NRHP).
- Category B** Unaltered historical resources that could be demolished and would warrant additional research to determine historical significance.
- Category C** Modified resources lacking historical integrity, or historical resources from the later period without important historical or architectural associations.

The evaluation of the resources for eligibility in the NRHP, Washington Heritage Register, or Seattle City Landmarks Register within the Green Line's APE was performed in consultation with the Washington SHPO and the Seattle Historic Preservation Officer and included a review of field evaluations and research for every resource. Concurrence was reached with the agencies regarding all determinations of eligibility. Records of the coordination effort and additional methodology are included in the Section 106 Cultural Resources Report (Appendix N). Research methods are also discussed in Appendix N, but included information within the Washington State Archives - Puget Sound Regional Branch, Seattle Public Library, Washington Office of Archaeology and Historic Preservation, Seattle Department of Neighborhoods Urban Conservation Division, Seattle Department of Construction and Land Use, and King County Assessor's records.

To facilitate their evaluation, the project historians undertook the following tasks:

- **Visual simulations.** Historians worked with the SMP visual resources team to identify specific locations within the APE where visual simulations could be used to assist in addressing effects to known historical resources. The SHPO and City of Seattle Historic Preservation Officer were also consulted to obtain input regarding the refinement of specific visual simulations. Draft simulations were provided to the agencies for review. A final copy of visual simulations relevant to known historical resources is included as an appendix to the Section 106 Cultural Resources Report (Appendix N).
- **Video and photographic survey.** The research effort also included a videotaped survey of the Green Line APE and photographs of known historical resources and their settings. The photographs were used for the visual simulations described above to assist in addressing effects to known historical resources.
- **Context statement.** A detailed context statement that provides background information on the neighborhood development within the Green Line APE is provided in the Section 106 Cultural Resources Report (Appendix N).
- **Field review.** The historians evaluated 642 properties or structures in the APE. Properties or structures of potential significance that would be demolished (Category B) were further assessed to determine eligibility for the NRHP, Washington Heritage Register, or listing as a Seattle Landmark. Category B properties, along with previously known (Category A) historical resources, are listed and mapped in the Section 106 Cultural Resources Report (Appendix N) by project segment.

Agency coordination included correspondence and work sessions with the OAHF regarding NEPA and Section 106 requirements; obtaining concurrence of the SHPO and the Seattle Historic Preservation Officer on the definition of the Green Line APE; and coordinating with the City of Seattle regarding compliance with SEPA and pertinent Seattle historic preservation laws. Staff provided OAHF and the City of Seattle Urban Conservation Division with statements of the NRHP significance for resources that were over 50 years of age and located within the APE. Project staff assessed potential effects to historic resources and prepared potential mitigation measures for resources listed on or determined eligible for historic registers. To meet SEPA and City of Seattle historic preservation requirements, staff provided the City Preservation Officer with background information and a current photograph for all buildings that are proposed for demolition under the Green Line alternatives. Staff also supplied the Urban Conservation Division with an assessment of project effects and mitigation measures for Seattle Landmarks.

Numerous agency work sessions were held with the SHPO and the City Historic Preservation Officer to determine the eligibility, impacts, and mitigation measures for all historical resources in the APE of the Green Line. Below is a list of meeting and agency work session dates, meeting subject, and persons

present. There were over 30 public meetings held for the project. For information on public meetings, see Appendix D, Public Involvement.

- May 16, 2003: Discussed the eligibility of historical resources in SODO and West Seattle, as well as written comments provided by OAHP and the City of Seattle regarding the historic resource information packets submitted by ENTRIX for SODO, West Seattle, and Ballard.
- May 21, 2003: Discussed the eligibility of and impacts to historical resources in SODO and West Seattle.
- May 23, 2003: Discussed the eligibility of and impacts to historical resources in Ballard.
- May 28, 2003: Discussed the eligibility, impacts, and mitigation measures for historical resources in Seattle Center and Downtown.
- June 4, 2003: Discussed the additional research requested by Allyson Brooks (OAHP) on selected resources in all segments and mitigation for all segments.

#### **4.11.2.1 Archaeological Resources and Traditional Cultural Places**

No recorded archaeological sites or traditional cultural places eligible for listing in the NRHP are located in the Green Line APE. The Sinking Ship Areaway Site (45KI685) is the only recorded archaeological site directly within the APE. Initial research indicates that the site is not eligible for listing in the NRHP because it lacks integrity of condition and would not contribute information important to history, and SMP is seeking concurrence from the SHPO for that determination. No traditional cultural places were identified in the APE through archival research or Tribal consultation. No significant traditional cultural places would be affected during construction or operation of the Green Line.

The probability for unknown hunter-fisher-gatherer, ethnographic period, and historic period archaeological resources was evaluated along all sections of the Green Line APE. By segment, the areas include:

- **Ballard.** Unknown significant hunter-fisher-gatherer or ethnographic period archaeological resources may occur beneath historic fill or lacustrine sediments on the former shoreline of Salmon Bay. No significant historic period archaeological resources would be present. There are no significant hunter-fisher-gatherer or ethnographic period archaeological resources identified at any of the station alternative locations. Historic period archaeological materials dating to the early and mid twentieth century may be present at some station alternatives, particularly those near Market Street.
- **Interbay.** Unknown significant hunter-fisher-gatherer or ethnographic period archaeological resources may occur beneath historic fill or lacustrine sediments on the former shoreline of Salmon Bay, on the former tideflats and marsh of Smith Cove, on the former tideflats and beach of Elliott Bay, and on a low terrace at the base of bluffs fronting Elliott Bay. Historic period archaeological resources may occur on the southeast side of Smith Cove, on the former shoreline of Elliott Bay, and on a low terrace at the base of bluffs covered by contemporary Elliott Avenue W. Mid-twentieth-century historic archaeological resources may be present at the Prospect and Elliott/Mercer station alternatives.
- **Queen Anne/Seattle Center/Belltown.** No hunter-fisher-gatherer, ethnographic period, or historic period archaeological resources would be present in most locations, although in the Seattle Center, unknown significant historic period archaeological resources dating between 1905 and 1917 may be present at the Fifth and Broad station alternatives.
- **Downtown.** Unknown significant hunter-fisher-gatherer and ethnographic period archaeological resources may be present beneath fill in the Yesler Way and King Street vicinity. Historic period

archaeological resources may be present beneath fill in the Pike Street, Madison Street, Yesler Way, and King Street vicinities and may be associated with late nineteenth-century commerce, dwellings, or churches.

- **SODO.** Unknown significant hunter-fisher-gatherer and ethnographic period archaeological resources may be present near King Street and on the former tideflats of Elliott Bay. Unknown historic period archaeological resources may occur in the King Street vicinity and on former tideflats of Elliott Bay.
- **West Seattle.** Unknown significant hunter-fisher-gatherer or ethnographic period archaeological resources may occur on the former tideflats of Elliott Bay, on the north end of Pigeon Point, and in the lower reach of the Longfellow Creek drainage. There could be unknown significant early twentieth-century historic period archaeological resources near the Delridge station alternatives. Along Fauntleroy Way SW, SW Alaska Street, and California Avenue SW, no significant archaeological resources would be likely.

#### **4.11.2.2 Historical Resources**

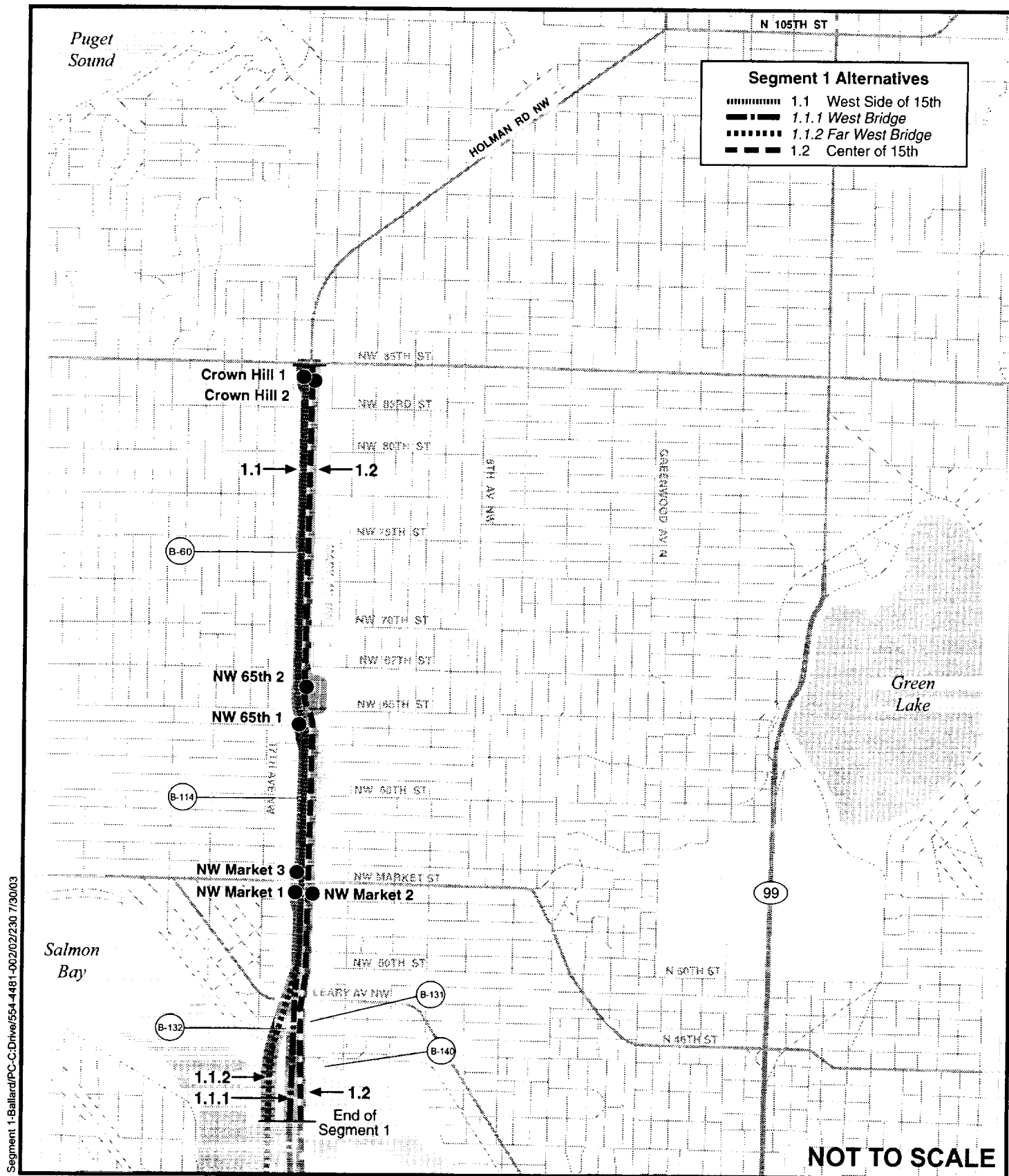
Resources determined to have historical significance are identified in Figure 4.11-1 and Figures 4.11-2 through 4.11-5, which also depict the APE for project alternatives. A list of significant historic resources located within the APE is provided in Table 4.11-1, as well as in Appendix N. Records of the process used to determine historic significance for individual properties are also referenced in Appendix N, in Agency Correspondence.

##### **Segment 1: Ballard Segment**

There are five historically significant resources in the Ballard Segment, including resources listed in or eligible for historic registers. The Ballard Bridge (B-140) is listed in the NRHP. Four additional buildings, including an industrial plant (B-132), a restaurant (B-131), an apartment building (B-114), and a residence (B-60), were determined eligible for inclusion in the NRHP. The background field inventory in the Ballard Segment reviewed 140 properties or structures in the APE. This segment consists of residential, commercial, and industrial buildings, with commercial and industrial properties increasing in density to the south approaching Salmon Bay and the older part of Ballard. Nineteen of the 140 properties or structures reviewed were Category A or B properties, which were researched further and evaluated for eligibility in historic registers.

##### **Segment 2: Interbay Segment**

Eleven resources in the Interbay Segment are listed in or have been determined eligible for historic registers, including three residences (I-19, I-25, and I-26), Tsubota Steel and Pipe (I-52), Leibold Communications, Inc. (I-66), the Ace Tank complex (I-72, I-73, I-74), Wilson Machine Works (I-80), Phillips Scale Co. (I-86), and a Fishermen's Terminal building (I-1C). The background field inventory in the Interbay Segment reviewed 99 properties or structures within the APE, including 38 resources that were Category A or B properties, which were researched and further evaluated for listing in historic registers. The north end of this segment is characterized by commercial and industrial structures, with multifamily residences to the east. The southern portion of the Interbay Segment includes an increased number of multifamily residential buildings along Elliott Avenue W.



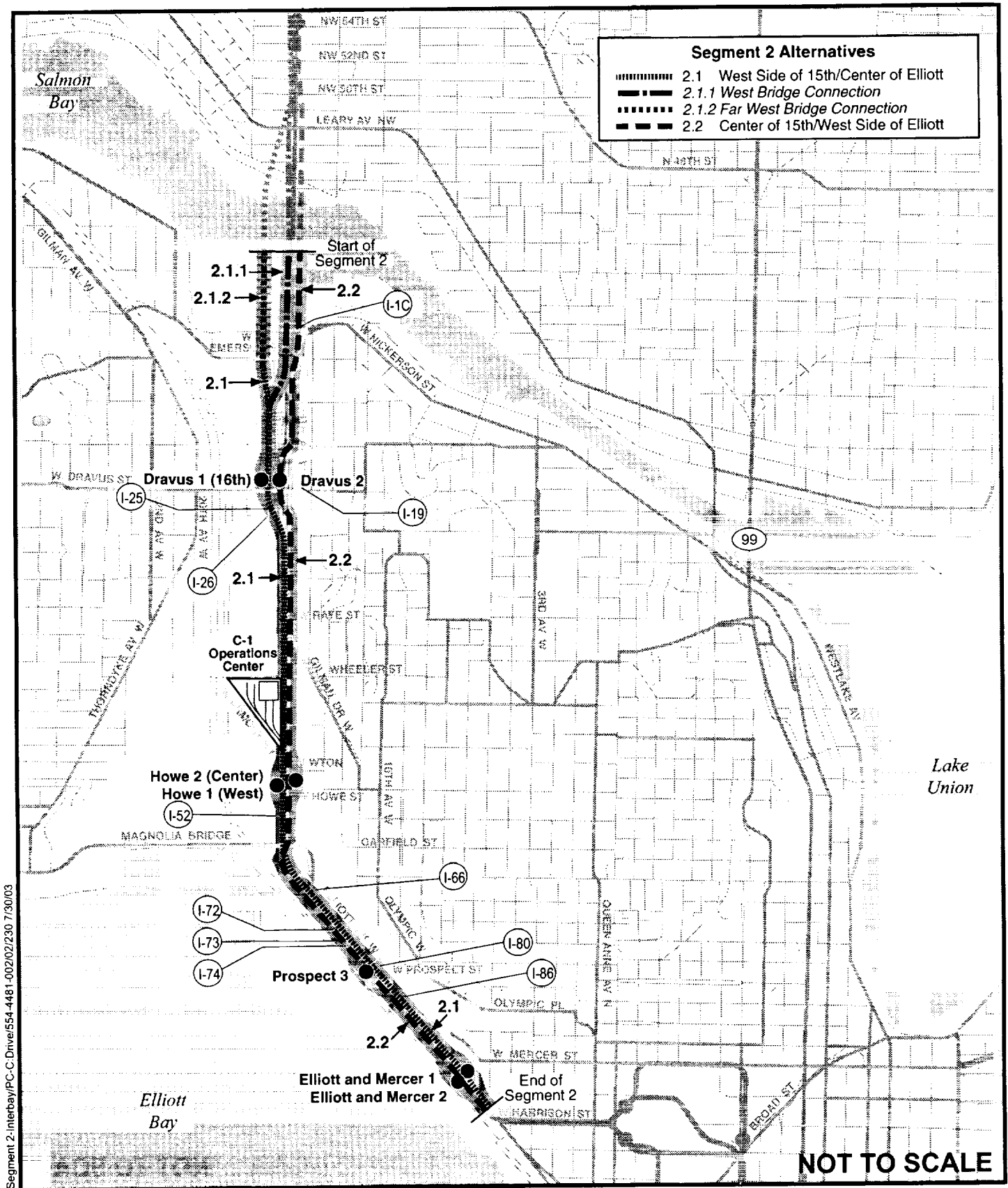
Segment 1-Ballard/PC-C:Drive/554-4481-002/02/230 7/30/03

SEATTLE MONORAIL PROJECT



Area of Potential Effect (APE)  
for Buildings and Structures

**Figure 4.11-1**  
**Segment 1: Ballard**  
**Historical Resources Listed in or**  
**Eligible for Historic Registers**

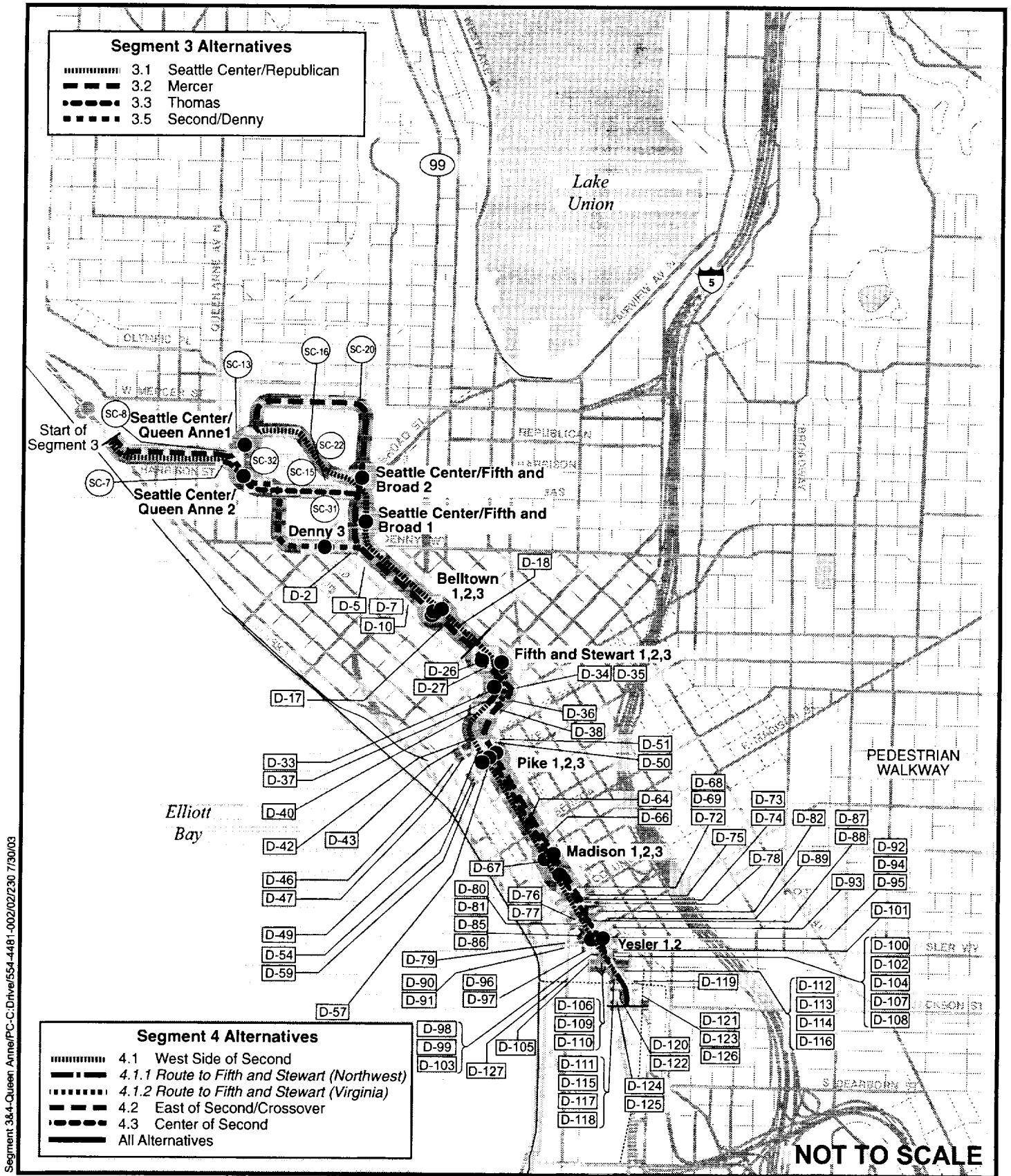


**Figure 4.11-2**  
**Segment 2: Interbay**  
**Historical Resources Listed in or**  
**Eligible for Historic Registers**

SEATTLE MONORAIL PROJECT



Area of Potential Effect (APE)  
 for Buildings and Structures



Segment 3&4-Queen Anne/PC-C.Drive/554-4481-002/02/230 7/30/03

SEATTLE MONORAIL PROJECT

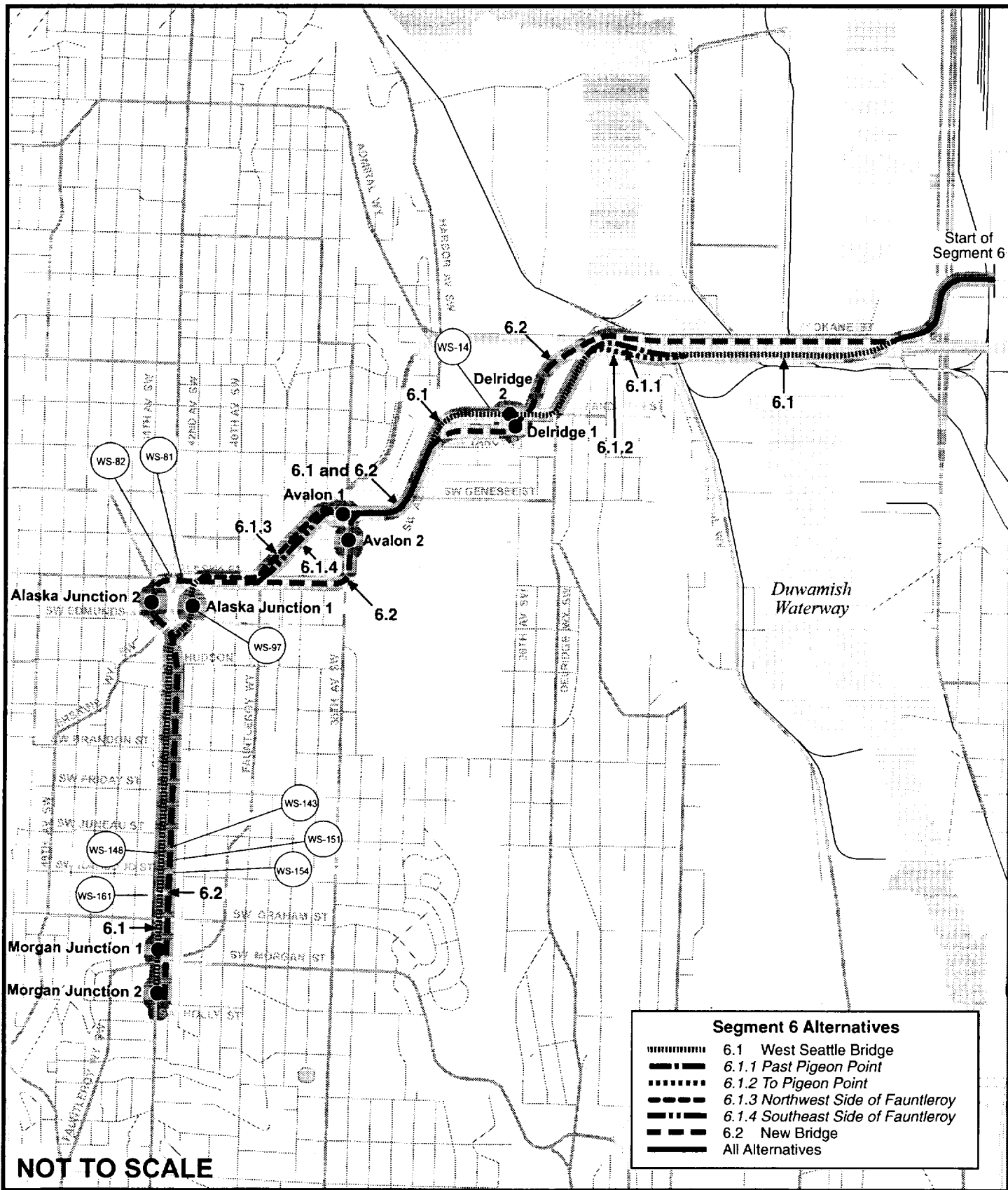


Area of Potential Effect (APE)  
for Buildings and Structures

**Figure 4.11-3**  
**Segment 3 and 4: Queen Anne/  
Seattle Center/Belltown/Downtown  
Historical Resources Listed in or  
Eligible for Historic Registers**







**Figure 4.11-5  
Segment 6: West Seattle  
Historical Resources Listed in or  
Eligible for Historic Registers**

**Table 4.11-1. Historic Resources in the Area of Potential Effect Listed in the NRHP or Washington Heritage Register, Designated a Seattle City Landmark, or Determined Eligible for the NRHP**

<b>Inventory No.</b>	<b>Resource/Address</b>	<b>Historic Register</b>
<b>Ballard Segment</b>		
B-60	Residence, 7353 15 <sup>th</sup> Avenue NW	NRHP Eligible
B-114	Apartments, 1505 NW 60 <sup>th</sup> Street	NRHP Eligible
B-131	Mike's Chili Parlor, 1447 NW Ballard Way	NRHP Eligible
B-132	Brekke Co. Steel Fabricators, 1526 NW 46 <sup>th</sup> Street	NRHP Eligible
B-140	Ballard Bridge	NRHP Listed
<b>Interbay Segment</b>		
I-1C	Residence and Storage, Fishermen's Terminal	NRHP Eligible
I-19	Residence, 1414 Dravus Street W	NRHP Eligible
I-25	Residence, 3036 16 <sup>th</sup> Avenue W	NRHP Eligible
I-26	Residence, 3032 16 <sup>th</sup> Avenue W	<i>Seattle Landmark Eligible</i>
I-52	Tsubota Steel and Pipe, 1641a 15 <sup>th</sup> Avenue W	NRHP Eligible
I-66	Leibold Communications Inc., 1450 15 <sup>th</sup> Avenue W	NRHP Eligible
I-72	Ace Tank, 1123a Elliott Avenue W	NRHP Eligible
I-73	Ace Tank, 1123b Elliott Avenue W	NRHP Eligible
I-74	Ace Tank, 1123c Elliott Avenue W	NRHP Eligible
I-80	Wilson Machine Works, 1038 Elliott Avenue W	NRHP Eligible
I-86	Phillips Scale Co., 934b Elliott Avenue W	NRHP Eligible
<b>Queen Anne/Seattle Center/Belltown Segment</b>		
SC-7	7 Queen Anne Avenue N	NRHP Eligible
SC-8	Delmasse Apartments, 26 W Harrison Street	NRHP Eligible <sup>1</sup>
SC-13	Queen Anne Apartments, 505 First Avenue N)	NRHP Eligible
SC-15	Center House (Seattle Center), 305 Harrison Street	NRHP Eligible
SC-16	Monorail Terminal, Office, and Track, Seattle Center	NRHP Eligible
SC-20	Auditorium Apartments, 605 Fifth Avenue N	NRHP Eligible
SC-22	Memorial Stadium, Seattle Center	NRHP Eligible
SC-31	Space Needle, 305 Harrison Street	NRHP Eligible, Seattle Landmark
SC-32	Seattle Center Fountain, 305 Harrison Street	NRHP Eligible
<b>Downtown Segment</b>		
D-2	Seattle, Chief of the Suquamish Statue, Fifth Avenue, Denny Way, and Cedar Street	Listed NRHP, Seattle Landmark
D-5	2619 Fifth Avenue	NRHP Eligible
D-7	420 Vine Street	NRHP Eligible
D-10	Fire Station No. 2, 2318 Fourth Avenue	NRHP Eligible, Seattle Landmark
D-17	420 Blanchard Street	NRHP Eligible
D-18	Fifth Avenue Court Apartments, 2132 Fifth Avenue	NRHP Eligible
D-26	Sheridan Apartments, 2011 Fifth Avenue	NRHP Eligible
D-27	Griffin Building, 2005 Fifth Avenue	Potentially Seattle Landmark Eligible
D-33	Securities Building, 1904 Third Avenue	NRHP Eligible
D-34	Times Square Building, 414 Olive Way	NRHP Listed, Seattle Landmark
D-35	McGraw Square, Fifth Avenue/Westlake Avenue/Olive Way/Stewart Street	Seattle Landmark
D-36	Mayflower Park Hotel, 1630 Fourth Avenue	NRHP Eligible
D-37	Centennial Building, 1900-1910 Fourth Avenue	
D-38	Bon Marche, 300 Stewart Street	NRHP Eligible, Seattle Landmark
D-40	Josephinum Hotel, 1900 Second Avenue	Listed NRHP, Seattle Landmark

**Table 4.11-1. Historic Resources in the Area of Potential Effect Listed in the NRHP or Washington Heritage Register, Designated a Seattle City Landmark, or Determined Eligible for the NRHP (continued)**

Inventory No.	Resource/Address	Historic Register
<b>Downtown Segment (continued)</b>		
D-42	Caffe D'Arte, 125 Stewart Street	NRHP Eligible
D-43	Inn at the Market, 1601 First Avenue	NRHP Listed (intrusion PPHD) <sup>2</sup>
D-46	Triangle Market, 1532 Pike Place	NRHP Listed (PPHD)
D-47	First and Pine Building, 1535 First Avenue	NRHP Listed (PPHD)
D-49	Doyle Building, 1527 Second Avenue	NRHP Listed
D-50	Haight Building (Second Ave and Pike Building), 211 Pine Street	NRHP Eligible
D-51	United Shopping Tower/Olympic Tower, 217 Pine Street	NRHP Listed, Seattle Landmark
D-54	Corner Market, NW corner of First Avenue and Pike Street	NRHP Listed (PPHD)
D-57	Eitel Building, 1511 Second Avenue	NRHP Eligible
D-59	Economy Market, SW corner of First Avenue and Pike Street	NRHP Listed (PPHD)
D-64	Hadfield Building, 1201 Second Avenue	NRHP Eligible, Seattle Landmark
D-66	Baillargeon Building, 1100 Second Avenue	NRHP Eligible
D-67	Federal Reserve Bank Building, 1015 Second Avenue	NRHP Eligible
D-68	Exchange Building, 821 First Avenue	NRHP Eligible, Seattle Landmark
D-69	Puget Sound Bank (Bank of California), 815 Second Avenue	NRHP Eligible, Seattle Landmark
D-72	Seattle Trust and Savings Bank, 804 Second Avenue	NRHP Eligible
D-73	Hong Kong and Shanghai Banking Corporation Clock, 720 Second Avenue	NRHP Eligible, Seattle Landmark
D-74	Foster and Marshall Building, 720 Second Avenue	NRHP Eligible
D-75	Chamber of Commerce Building, 215 Columbia Street	NRHP Eligible
D-76	Metsker Maps, 700 First Avenue	NRHP Listed (PSHD)
D-77	Hoge Building (Carson Boren Home Site), 705 Second Avenue	NRHP Listed, Seattle Landmark
D-78	Dexter Horton Building, 710 Second Avenue	NRHP Eligible, Seattle Landmark
D-79	Mutual Life Building, 605 First Avenue	NRHP Listed (PSHD)
D-80	Lowman Building, 107 Cherry Street	NRHP Listed (PSHD)
D-81	Broderick Building (Seattle's Best Coffee), 619 Second Avenue	NRHP Listed (PSHD)
D-82	Alaska Building, 618 Second Avenue	NRHP Listed (PSHD)
D-85	Pioneer Square Mall, 606 First Avenue	NRHP Listed (PSHD)
D-86	Butler Garage, 601 Second Avenue	NRHP Listed (PSHD)
D-87	610 Second Avenue	NRHP Listed (PSHD)
D-88	Hartford Building, 600 Second Avenue	NRHP Listed (PSHD)
D-89	Lyon Building, 601 Third Avenue	NRHP Eligible
D-90	Café Paloma, 93 Yesler Way	NRHP Listed (PSHD)
D-91	Tully's Coffee, 99 Yesler Way	NRHP Listed (PSHD)
D-92	Collins Building, 520 Second Avenue	NRHP Listed (PSHD)
D-93	519 Third Avenue	NRHP Listed (PSHD)
D-94	512 Second Avenue	NRHP Listed (PSHD)
D-95	Smith Tower, 502 Second Avenue	NRHP Listed (PSHD), Seattle Landmark
D-96	Merchant's Café, 109 Yesler Way	NRHP Listed (PSHD)
D-97	Bohemian Nightclub, 115 Yesler Way	NRHP Listed (PSHD)
D-98	Flanagan and Lane, 102 Yesler Way	NRHP Listed (PSHD)
D-99	Metropole Market, 423 Second Avenue Extension S	NRHP Listed (PSHD)
D-100	201 Yesler Way	NRHP Listed (PSHD)

Table 4.11-1. Historic Resources in the Area of Potential Effect Listed in the NHP or Washington Heritage Register, Designated a Seattle City Landmark, or Determined Eligible for the NHP (continued)

Inventory No.	Resource/Address	Historic Register
<b>Downtown Segment (continued)</b>		
D-101	Frye Apartments, 223 Yesler Way	NRHP Listed (PSHD)
D-102	408 Second Avenue Extension S	NRHP Listed (Intrusion PSHD) <sup>2</sup>
D-103	411 Second Avenue Extension S	NRHP Listed (Intrusion PSHD) <sup>2</sup>
D-104	410 Second Avenue Extension S	NRHP Listed (Intrusion PSHD) <sup>2</sup>
D-105	The Last Supper Club, 124 S Washington Street	NRHP Listed (PSHD)
D-106	401 Second Avenue Extension S	NRHP Listed (Intrusion PSHD) <sup>2</sup>
D-107	406 Second Avenue Extension S	NRHP Listed (PSHD)
D-108	400 Second Avenue Extension S	NRHP Listed (PSHD)
D-109	165 S Washington Street	NRHP Listed (PSHD)
D-110	McCoy's Firehouse, 173 S Washington Street	NRHP Listed (Intrusion PSHD) <sup>2</sup>
D-111	201 S Washington Street	NRHP Listed (PSHD)
D-112	Union Gospel Mission, 211 S Washington Street	NRHP Listed (Intrusion PSHD) <sup>2</sup>
D-113	Mathews and Chesnin Attorneys, 219 S Washington Street	NRHP Listed (PSHD)
D-114	Union Gospel Mission, 221 S Washington Street	NRHP Listed (PSHD)
D-115	313 Second Avenue Extension S	NRHP Listed (PSHD)
D-116	208 Second Avenue Extension S	NRHP Listed (PSHD)
D-117	Masins Fine Furniture, 220 S Main Street	NRHP Listed (PSHD)
D-118	Comedy Underground, 222 S Main Street	NRHP Listed (PSHD)
D-119	Seattle Fire Department Fire Prevention, 220 Third Avenue	NRHP Listed (PSHD)
D-120	213 S Main Street	NRHP Listed (PSHD)
D-121	222 S Main Street	NRHP Listed (PSHD)
D-122	James Harris Gallery, 307 Second Avenue Extension S	NRHP Listed (PSHD)
D-123	Seattle Lighting Fixture Co., 210 Second Avenue Extension S	NRHP Listed (Intrusion PSHD) <sup>2</sup>
D-124	Vacant, 208 S Jackson Street	NRHP Listed (PSHD)
D-125	Leathers/Gourmet Sausage Co., 315 S Jackson Street	NRHP Listed (PSHD)
D-126	King Street Station, 301 S Jackson Street	NRHP Listed (PSHD)
D-127	Pioneer Square Areaways, Underneath Pioneer Square	NRHP Eligible
<b>SODO Segment</b>		
S-26	Bank of America, 2764 First Avenue S	NRHP Eligible
S-58	Markey Machinery Co., 79 S Horton Street	NRHP Eligible
S-61	Rainier Cold Storage Building A, southeast corner of S Horton Street and Colorado Avenue S	NRHP Eligible
<b>West Seattle Segment</b>		
WS-14	Nucor Steel Mill, 2424 SW Andover Street	NRHP Eligible
WS-81	Cherry Creek Furniture, 4554 California Avenue SW	Seattle Landmark Eligible
WS-82	Easy Street Records, 4302 SW Alaska Street	Seattle Landmark Eligible
WS-97	Curious Kidstuff, 4740 California Avenue SW	Seattle Landmark Eligible
WS-143	Farmers Insurance Group, 5922 California Avenue SW	NRHP Eligible
WS-148	Residence, 5933 California Avenue SW	NRHP Eligible
WS-151	Residence, 5948 California Avenue SW	NRHP Eligible
WS-154	Residence, 5956-5958 California Avenue SW	NRHP Eligible
WS-161	Residence, 6021 California Avenue SW	NRHP Eligible
<sup>1</sup> This building is not eligible by itself, but it is eligible as part of a group of similar properties. <sup>2</sup> Intrusion Pike Place Historic District/Pioneer Square Historic District (PPHD/PSHD) = an intrusion is a building that falls within the boundaries of the historic district but is not a contributing structure to that district.		

### **Segment 3: Queen Anne/Seattle Center/Belltown Segment**

Nine historically significant resources are listed in or eligible for historic registers and are within the Queen Anne/Seattle Center/Belltown Segment APE. The historically significant resources within this segment include four individual apartment buildings (SC-7, SC-8, SC-13, and SC-20), Center House (SC-15); Monorail Terminal, Office, and Track (SC-16); Memorial Stadium (SC-22); Space Needle (SC-31); and the Seattle Center Fountain (SC-32). In the background field investigation, 32 properties or structures were reviewed, including 14 properties or structures that were Category A or B properties, which were researched further and evaluated for listing in historic registers. Apart from the Seattle Center itself, this segment consists of a mix of high-density residential (apartments) and small- to medium-sized commercial buildings. A significant amount of land in this segment is occupied by parking facilities, especially adjacent to the Seattle Center campus.

### **Segment 4: Downtown Segment**

The Downtown Segment includes the original center of development of the City of Seattle (Pioneer Square) and one of the first areas to be expanded as the city grew into the region's dominant commercial center. It includes both the Pioneer Square and Pike Place Historic Districts. Eighty-two buildings within this segment are listed in or eligible for historic registers. A large number of historical resources that were identified in the APE have been previously determined listed in the NRHP and as Seattle Landmarks as part of the Pioneer Square Historic District and Pioneer Square Preservation District.

The NRHP Pike Place Historic District boundaries extend roughly from Western Avenue on the west, Pike Street on the south, First Avenue on the east, and Virginia Street on the north. The local Pike Place Preservation District shares similar boundaries. The NRHP Pioneer Square Historic District extends roughly from Alaskan Way to the west, S King Street to the south, Fourth and Fifth Avenues S to the east, and Columbia, Cherry, James, and Jefferson Streets to the north. However, the NRHP district boundaries extend further in several areas, including the area bordered by First and Occidental Avenues S south of S King Street. The local Pioneer Square Preservation District boundaries encompass most of this same area, but include more territory, including additional area bordered by First and Occidental Avenues S south of S King Street, and a dock at the foot of S Washington Street. The historic properties within these districts are located in both the Green Line's SODO and Downtown Segments. To evaluate affected resources and effects to these resources as part of a single historic district, all historical resources within the Pioneer Square Historic District and Pioneer Square Preservation District have been assessed as part of the Downtown Segment.

Properties along the southern part of Second Avenue in this segment include the 42-story Smith Tower (1914), the Dexter Horton Building (1924), the Hartford Building (1929), and the Exchange Building (1930), which also was one of Seattle's last and most stylish Art Deco skyscrapers. After this time, most new business construction was happening uptown near the Metropolitan Tract. As the new business district developed and thrived, Pioneer Square slid into decline; a "Hooverville" (community of homeless people) developed along the waterfront south of the Square during the Depression (Crowley 1998; Woodbridge and Montgomery 1980). Despite the replacement of many of the original commercial buildings over the years, numerous historical buildings remain.

Pike Place Market, a block west of the proposed Green Line alternative alignments, is a Seattle icon made up of a "maze of structures that have housed a continuously operating public farmers' market and miscellaneous other merchants since 1907" (Crowley 1998:77). Developers built a permanent arcade to house the farmers and vendors and also constructed the Outlook Hotel and the Triangle Market. The market area was expanded

in 1910 and again in 1911; a few years later, the Fairley (Main Market) Building was erected. By 1917, all the main buildings of the current market were in place. The neon sign and giant clock were added around 1930.

A total of 110 Category A and B properties were evaluated for listing in historic registers. The areaways, located underground mainly within the Pioneer Square Historic District, have been identified as one resource (D-127) (additional information on the areaways is included in the Section 106 Cultural Resources Report, Appendix N). Details on the individual resources are provided within the Section 106 Cultural Resources Report (Appendix N) and also were included in the documentation provided to the SHPO and the City of Seattle.

### **Segment 5: SODO Segment**

As noted above, historical resources in the Pioneer Square Historic District and Pioneer Square Preservation District were evaluated as part of the Downtown Segment.

The SODO Segment historical resources inventory considers the area south of S King Street. Three resources were determined eligible for the NRHP: the Markey Machinery Building (S-58), Rainier Cold Storage Building A (S-61), and the Bank of America branch (S-26). The background field inventory for the SODO Segment reviewed 61 properties or structures in the APE, and seven were researched further and evaluated for listing in historic registers.

The SODO area is a commercial and industrial part of the city that exhibits a land use trend initiated by the railroads that built trestles over Elliott Bay tidelands before they were filled. Railroad companies moved quickly to occupy the reclaimed lands as filling progressed. A series of public stadium projects has altered the northernmost portion of the SODO Segment, but many older commercial buildings remain south of Safeco Field.

### **Segment 6: West Seattle Segment**

Nine resources within the West Seattle Segment possess historical significance. The historical resources within the segment include the Nucor Steel Mill (WS-14), Curious Kidstuff (WS-97), Farmers Insurance Group Building (WS-143), Cherry Creek Furniture (WS-81), Easy Street Records (WS-82), and four residential buildings (WS-148, WS-151, WS-154, and WS-161). Four residential buildings were eligible for inclusion in the NRHP, and three commercial buildings were previously determined eligible as Seattle Landmarks. The background field inventory of the West Seattle Segment considered 186 properties or structures within the APE, including 31 that were evaluated for eligibility for historic registers. The West Seattle project area is largely residential, with small businesses and houses remodeled for commercial use clustered around major street intersections.

#### **4.11.3 Impacts**

Impacts to archaeological resources would be limited to Green Line construction, including locations of guideway columns, bridge piers, Operations Center alternatives, several stations where buildings could be removed, and/or stations where grading could penetrate fill into native soils. Construction impacts are expected to be localized at a few of many guideway columns or at a few of many stations. Most unknown or recorded significant archaeological resources that may occur in the APE would not be affected because of the small construction footprints of guideway columns, although underground utility relocation activities would also encounter archeological resources. No effects to archaeological resources are expected from Green Line operation.

Historical resources listed in or eligible for historic registers (Category A or B resources) were evaluated to determine potential effects of station and alignment alternatives on those resources. Analysis of potential effects to historical resources assessed the different actions that could occur during Green Line construction and operation. When interpreting short- and long-term impacts under SEPA and NEPA that may cause adverse effects, the following criteria are evaluated:

- **Demolition or Alteration of Property:** The demolition or extensive alteration of all or part of the resource.
- **Isolation/Alteration of Surrounding Environment:** Temporary or permanent restrictions of access to a historic resource or a change in the character of the property's setting.
- **Traffic Congestion/Parking/Access:** Congestion arising from changes in traffic patterns, parking, and access to historical resources.
- **Visual:** The introduction of modern construction or the removal of historical resources adjacent to a historic property that are out of character with or alter the resource's historical setting.
- **Introduction of New Construction:** The addition of new construction that is not compatible with the existing architecture of historical resources.
- **Structural Instability:** Introduction of vibration during construction or operation that would cause damage to historical resources.
- **Noise:** The introduction of audible elements that are out of character with the historic resource and its established use such that its use may be altered or abandoned.
- **Change of Use:** The change in use of a historic resource brought about by construction or operation-related activities that make it no longer physically or financially feasible or desirable to maintain the current use.
- **Vibration:** Construction or operation techniques that would create vibrations such that a resource may experience damages such as the loosening of paint or mortar, cracking of mortar or plaster, weakening of structural elements, or crumbling masonry.
- **Temporary Dirt/Unintended Damage:** The introduction of atmospheric elements that may alter or damage a historic resource.
- **Neglect:** neglect of a resource resulting in its deterioration or demolition. This is a potential effect assessed under no-build alternatives (e.g., the No Action Alternative).

This Draft EIS analysis has assumed conservatively large stations, and the actual station development could be smaller with less visual impact. In addition, it should be noted that in most cases SMP evaluated alternatives that would not require demolition of historic properties. The following discussion of potential effects on historical resources within each Green Line segment provides the location of the historical resources and the types of potential effects for each alignment alternative and station alternative. Table 4.11-2 summarizes the numbers of historical resources that could experience adverse effects. Table 4.11-3 provides information on the types of effects under each alternative. The adverse effects discussion for each segment includes a summary of type of historical resources within the alignment and station alternatives and the types of effects associated with each resource type. (Specific visual simulations are located in the Section 106 Cultural Resources Report, Appendix N.) Other sections of this Draft EIS, including Transportation (4.1), Displacements and Relocation (4.2), Land Use and Neighborhoods (4.3), Visual Quality and Aesthetic Resources (4.5), Noise and Vibration (4.7), and Construction (4.17), provide additional discussion on potential impacts that could affect historic properties, and these effects were also considered in the determination of effects to historic properties. However, the secondary impacts from these other environmental areas were not found to adversely affect

historic properties. In particular, there are no long-term operational vibration impacts that would create adverse effects to historical resources.

**Table 4.11-2. Summary of Adverse Effects to Historical Resources**

<b>Alignment Alternative</b>	<b>Historic</b>
<b>1. Ballard</b>	
1.1 West Side of 15th	5
1.2 Center of 15 <sup>th</sup>	4
<b>2. Interbay</b>	
2.1 West Side of 15 <sup>th</sup> /Center of Elliott	8 to 9
2.2 Center of 15th/West Side of Elliott	7
<b>3. Queen Anne/Seattle Center/Belltown</b>	
3.1 Seattle Center/Republican	6
3.2 Mercer	4
3.3 Thomas	4
3.5 Second/Denny	2
<b>4. Downtown</b>	
4.1 West Side of Second	79 to 81
4.2 East Side of Second with Crossover	79
4.3 Center of Second	79
<b>5. SODO</b>	
5.1 East Side of Third/Utah	2
5.2 West Side of Third/Utah	3
<b>6. West Seattle</b>	
6.1 West Seattle Bridge	5
6.2 New West Seattle Bridge	6
<b>Operations Center</b>	
C-1 Interbay	0
C-2 SODO	0



**Table 4.11-3. Preliminary Evaluation of Effect and Adverse Effects by Alternatives**

Resource/Address		List Status	No Adverse Effect	Adverse Effects		
				Demolition/ Alteration of Property	Isolation/ Alteration of Surrounding Environment	Visual
Ballard Segment, Alternative 1.1 - West Side of 15 <sup>th</sup>						
B-60	Residence 7353 15 <sup>th</sup> Avenue NW	Eligible				X
B-114	Apartments 1505 NW 60 <sup>th</sup> Street	Eligible				X
B-131	Mike's Chili Parlor 1447 NW Ballard Way	Eligible				X
B-132	Brekke Co. Steel Fabricators 1526 NW 46 <sup>th</sup> Street	Eligible				X
B-140	Ballard Bridge	NRHP			X	X
Ballard Segment, Alternative 1.2 - Center of 15 <sup>th</sup>						
B-60	Residence 7353 15 <sup>th</sup> Avenue NW	Eligible				X
B-114	Apartments 1505 NW 60 <sup>th</sup> Street	Eligible				X
B-131	Mike's Chili Parlor 1447 NW Ballard Way	Eligible		X	X	X
B-140	Ballard Bridge	NRHP			X	X
Interbay Segment, Alternative 2.1 - West Side of 15 <sup>th</sup> /Center of Elliott						
I-25	Residence 3036 16 <sup>th</sup> Avenue W	Eligible		X		
I-26	Residence 3032 16 <sup>th</sup> Avenue W	Potential SLE		X		
I-52	Tsubota Steel and Pipe 1641a 15 <sup>th</sup> Avenue W	Eligible				X
I-66	Leibold Communications Inc. 1450 15 <sup>th</sup> Avenue W	Eligible	X			
I-72	Ace Tank 1123a Elliott Avenue W	Eligible				X
I-73	Ace Tank 1123b Elliott Avenue W	Eligible				X
I-74	Ace Tank 1123c Elliott Avenue W	Eligible				X
I-80	Wilson Machine Works 1038 Elliott Avenue W	Eligible				X
I-86	Phillips Scale Co. 934b Elliott Avenue W	Eligible				X
Interbay Segment, Alternative 2.1.1 - West Bridge Connection						
I-1C	Residence and Storage Fishermen's Terminal	Eligible				X
Interbay Segment, Alternative 2.1.2 - Far West Bridge Connection						
No eligible historic resources						

**Table 4.11-3. Preliminary Evaluation of Effect and Adverse Effects by Alternatives (continued)**

		Adverse Effects				
Resource/Address	List Status	No Adverse Effect	Demolition/ Alteration of Property	Isolation/ Alteration of Surrounding Environment	Visual	
Interbay Segment, Alternative 2.2 - Center of 15 <sup>th</sup> /West Side of Elliott						
I-1C Residence and Storage Fishermen's Terminal	Eligible				X	
I-19 Residence 1414 Dravus Street W	Eligible	X				
I-52 Tsubota Steel and Pipe 1641a 15 <sup>th</sup> Avenue W	Eligible				X	
I-66 Leibold Communications Inc. 1450 15 <sup>th</sup> Avenue W	Eligible	X				
I-72 Ace Tank 1123a Elliott Avenue W	Eligible				X	
I-73 Ace Tank 1123b Elliott Avenue W	Eligible				X	
I-74 Ace Tank 1123c Elliott Avenue W	Eligible				X	
I-80 Wilson Machine Works 1038 Elliott Avenue W	Eligible				X	
I-86 Phillips Scale Co. 934b Elliott Avenue W	Eligible				X	
Seattle Center Segment, Alternative 3.1 - Seattle Center/Republican						
SC-7 7 Queen Anne Avenue N	Eligible				X	
SC-8 Delmasse Apartments** 26 W Harrison Street	Eligible		X			
SC-13 Queen Anne Apartments 505 First Avenue N	Eligible	X				
SC-15 Center House (Seattle Center) 305 Harrison Street	Eligible				X	
SC-16 Monorail Terminal, Office, and Track - Seattle Center	Eligible		X			
SC-22 Memorial Stadium	Eligible				X	
SC-31 Space Needle	Eligible	X				
SC-32 Seattle Center Fountain	Eligible	X				
** The Delmasse Apartments is not eligible by itself, but is eligible as part of a group of similar properties.						
Seattle Center Segment, Alternative 3.2 - Mercer						
SC-7 7 Queen Anne Avenue N	Eligible				X	
SC-8 Delmasse Apartments** 26 W Harrison Street	Eligible		X			
SC-13 Queen Anne Apartments 505 First Avenue N	Eligible	X				
SC-16 Monorail Terminal, Office, and Track - Seattle Center	Eligible				X	
SC-20 Auditorium Apartments 605 Fifth Avenue N	Eligible				X	
SC-31 Space Needle	Eligible	X				
SC-32 Seattle Center Fountain	Eligible	X				

\*\* The Delmasse Apartments is not eligible by itself, but is eligible as part of a group of similar properties.

**Table 4.11-3. Preliminary Evaluation of Effect and Adverse Effects by Alternatives (continued)**

			Adverse Effects			
Resource/Address		List Status	No Adverse Effect	Demolition/ Alteration of Property	Isolation/ Alteration of Surrounding Environment	Visual
<b>Seattle Center Segment, Alternative 3.3 - Thomas</b>						
SC-7	7 Queen Anne Avenue N	Eligible				X
SC-8	Delmasse Apartments** 26 W Harrison Street	Eligible				X
SC-13	Queen Anne Apartments 505 First Avenue N	Eligible	X			
SC-15	Center House (Seattle Center) 305 Harrison Street	Eligible				X
SC-16	Monorail Terminal, Office, and Track - Seattle Center	Eligible		X		
SC-31	Space Needle	Eligible	X			
SC-32	Seattle Center Fountain	Eligible	X			
** The Delmasse Apartments is not eligible by itself, but is eligible as part of a group of similar properties.						
<b>Seattle Center Segment, Alternative 3.5 - Second/Denny</b>						
SC-7	7 Queen Anne Avenue N	Eligible				X
SC-8	Delmasse Apartments** 26 West Harrison Street	Eligible				X
SC-16	Monorail Terminal, Office, and Track - Seattle Center	Eligible		X		
** The Delmasse Apartments is not eligible by itself, but is eligible as part of a group of similar properties.						
<b>Downtown Segment, Alternative 4.1 - West Side of Second</b>						
D-2	Seattle, Chief of the Suquamish Statue/Fifth Avenue, Denny Way, and Cedar Street	Listed NR				X
D-5	2619 Fifth Avenue	Eligible				X
D-7	420 Vine Street	Eligible				X
D-10	Fire Station No. 2 2318 Fourth Avenue	Eligible	X			
D-17	420 Blanchard Street	Eligible				X
D-18	Fifth Avenue Court Apartments 2132 Fifth Avenue	Eligible				X
D-26	Sheridan Apartments 2011 Fifth Avenue	Eligible		X		
D-27	Griffin Building 2005 Fifth Avenue	Potential SLE*				X
D-37	Securities Building 1904 Third Avenue	Eligible				X
D-33	Centennial Building 1900-1910 Fourth Avenue	Eligible		X <sup>a</sup>		X <sup>b</sup>
D-34	Times Square Building 414 Olive Way	Listed NR				X
D-36	Mayflower Park Hotel 1630 Fourth Avenue	Eligible				X
D-38	Bon Marche 300 Stewart Street	Eligible				X
D-40	Josephinum Hotel 1900 Second Avenue	Listed NR				X

**Table 4.11-3. Preliminary Evaluation of Effect and Adverse Effects by Alternatives (continued)**

	Resource/Address	List Status	No Adverse Effect	Adverse Effects		
				Demolition/ Alteration of Property	Isolation/ Alteration of Surrounding Environment	Visual
D-42	Caffe D'Arte 125 Stewart Street	Eligible				X
D-43	Inn at the Market 1601 First Avenue	Listed NR PPHD				X
D-46	Triangle Market 1532 Pike Place	Listed NR PPHD				X
D-47	First and Pine Building 1535 First Avenue	Listed NR PPHD				X
D-49	Doyle Building 1527 Second Avenue	Listed NR				X
D-50	Haight Building (Second & Pike Building) 211 Pine Street	Eligible				X
D-51	United Shopping Tower/Olympic Tower 217 Pine Street	Listed NR				X
D-54	Corner Market NW corner of First Avenue and Pike Street	Listed NR PPHD				X <sup>c</sup>
D-57	Eitel Building 1511 Second Avenue	Eligible		X <sup>d</sup>		X <sup>c</sup>
D-59	Economy Market SW corner of First Avenue and Pike Street	Listed NR PPHD				X <sup>c</sup>
D-64	Hadfield Building 1201 Second Avenue	Eligible				X
D-66	Baillargeon Building 1100 Second Avenue	Eligible				X
D-67	Federal Reserve Bank Building 1015 Second Avenue	Eligible		X		
D-68	Exchange Building 821 First Avenue	Eligible				X
D-69	Puget Sound Bank (Bank of California) 815 Second Avenue	Eligible				X
D-72	Seattle Trust and Savings Bank 804 Second Avenue	Eligible				X
D-73	Hong Kong and Shanghai Banking Corporation Clock 720 Second Avenue	Eligible				X
D-74	Foster and Marshall Building 720 Second Avenue	Eligible				X
D-75	Chamber of Commerce Building 215 Columbia Street	Eligible				X
D-76	Metsker Maps 700 First Avenue	Listed NR PSHD				X
D-77	Hoge Building (Carson Boren Home Site) 705 Second Avenue	Listed NR				X

**Table 4.11-3. Preliminary Evaluation of Effect and Adverse Effects by Alternatives (continued)**

	Resource/Address	List Status	No Adverse Effect	Adverse Effects		
				Demolition/ Alteration of Property	Isolation/ Alteration of Surrounding Environment	Visual
D-78	Dexter Horton Building 710 Second Avenue	Eligible				X
D-79	Mutual Life Building 605 First Avenue	Listed NR PSHD				X
D-80	Lowman Building 107 Cherry Street	Listed NR PSHD				X
D-81	Broderick Building (Seattle's Best Coffee) 619 Second Avenue	Listed NR PSHD				X
D-82	Alaska Building 618 Second Avenue	Listed NR PSHD				X
D-85	Pioneer Square Mall 606 First Avenue	Listed NR PSHD				X
D-86	Butler Garage 601 Second Avenue	Listed NR PSHD				X
D-87	610 Second Avenue	Listed NR PSHD				X
D-88	Hartford Building 600 Second Avenue	Listed NR PSHD				X
D-89	Lyon Building 601 Third Avenue	Eligible				X
D-90	Café Paloma 93 Yesler Way	Listed NR PSHD				X
D-91	Tully's Coffee 99 Yesler Way	Listed NR PSHD				X
D-92	Collins Building 520 Second Avenue	Listed NR PSHD				X
D-93	519 Third Avenue	Listed NR PSHD				X
D-94	512 Second Avenue	Listed NR PSHD				X
D-95	Smith Tower 502 Second Avenue	Listed NR PSHD				X
D-96	Merchant's Café 109 Yesler Way	Listed NR PSHD				X
D-97	Bohemian Nightclub 115 Yesler Way	Listed NR PSHD				X
D-98	Flanagan and Lane 102 Yesler Way	Listed NR PSHD				X
D-99	Metropole Market 423 Second Avenue Extension S	Listed NR PSHD				X
D-100	201 Yesler Way	Listed NR PSHD				X
D-101	Frye Apartments 223 Yesler Way	Listed NR PSHD				X
D-102	408 Second Avenue Extension S	Listed NR PSHD				X

**Table 4.11-3. Preliminary Evaluation of Effect and Adverse Effects by Alternatives (continued)**

	Resource/Address	List Status	No Adverse Effect	Adverse Effects		
				Demolition/ Alteration of Property	Isolation/ Alteration of Surrounding Environment	Visual
D-103	411 Second Avenue Extension S	Listed NR PSHD				X
D-104	410 Second Avenue Extension S	Listed NR PSHD				X
D-105	The Last Supper Club 124 S Washington Street	Listed NR PSHD				X
D-106	401 Second Avenue Extension S	Listed NR PSHD				X
D-107	406 Second Avenue Extension S	Listed NR PSHD				X
D-108	400 Second Avenue Extension S	Listed NR PSHD				X
D-109	165 S Washington Street	Listed NR PSHD				X
D-110	McCoys Firehouse 173 S Washington Street	Listed NR PSHD				X
D-111	201 S Washington Street	Listed NR PSHD				X
D-112	Union Gospel Mission 211 S Washington Street	Listed NR PSHD				X
D-113	Matthews and Chesnin Attorneys 219 S Washington Street	Listed NR PSHD				X
D-114	Union Gospel Mission 221 S Washington Street	Listed NR PSHD				X
D-115	313 Second Avenue Extension S	Listed NR PSHD				X
D-116	208 Second Avenue Extension S	Listed NR PSHD				X
D-117	Masins Fine Furniture 220 S Main Street	Listed NR PSHD				X
D-118	Comedy Underground 222 S Main Street	Listed NR PSHD				X
D-119	Seattle Fire Department Fire Prevention 220 Third Avenue	Listed NR PSHD				X
D-120	213 S Main Street	Listed NR PSHD				X
D-121	222 S Main Street	Listed NR PSHD				X
D-122	James Harris Gallery 307 Second Avenue Extension S	Listed NR PSHD				X
D-123	Seattle Lighting Fixture Co. 210 Second Avenue Extension S	Listed NR PSHD				X
D-124	Vacant 208 S Jackson Street	Listed NR PSHD				X
D-125	Leathers/Gourmet Sausage Co. 315 S Jackson Street	Listed NR PSHD				X

**Table 4.11-3. Preliminary Evaluation of Effect and Adverse Effects by Alternatives (continued)**

	Resource/Address	List Status	No Adverse Effect	Adverse Effects		
				Demolition/ Alteration of Property	Isolation/ Alteration of Surrounding Environment	Visual
D-126	King Street Station 301 S Jackson Street	Listed NR PSHD				X
D-127	Pioneer Square Areaways Underneath Pioneer Square	Eligible NR	X			
<b>Downtown Segment, Alternative 4.2 - East Side of Second with Crossover</b>						
D-26	Sheridan Apartments 2011 Fifth Avenue	Eligible		X		
D-27	Griffin Building 2005 Fifth Avenue	Potential SLE*		X		
[otherwise same properties as Alignment 4.1, but avoiding demolition of D-33, D-57, and D-67]						
<b>Downtown Segment, Alternative 4.3 - Center of Second</b>						
[same properties as Alignment 4.1, but avoiding demolition of D-57 and D-67]						
<b>SODO Segment, Alternative 5.1 - East Side of Third/Utah</b>						
S-58	Markey Machinery Co. 79 S Horton Street	Eligible				X
S-61	Rainier Cold Storage Building A, southeast corner of S Horton Street and Colorado Avenue S	Eligible				X
<b>SODO Segment, Alternative 5.2 - West Side of Third/Utah</b>						
S-26	Bank of America 2764 First Avenue S	Eligible				X
S-58	Markey Machinery Co. 79 S Horton Street	Eligible				X
S-61	Rainier Cold Storage Building A, southeast corner of S Horton Street and Colorado Avenue S	Eligible				X
<b>West Seattle Segment, Alternative 6.1 - West Seattle Bridge</b>						
WS-14	Nucor Steel Mill 2424 SW Andover Street	Eligible				X
WS-97	Curious Kidstuff 4740 California Avenue SW	Potential SLE (City of Seattle, Historic Property Inventory, 2001) *				X
WS-143	Farmers Insurance Group 5922 California Avenue SW	Eligible				X
WS-148	Residence 5933 California Avenue SW	Eligible	X			
WS-151	Residence 5948 California Avenue SW	Eligible				X
WS-154	Residence 5956-5958 California Avenue SW	Eligible				X

**Table 4.11-3. Preliminary Evaluation of Effect and Adverse Effects by Alternatives (continued)**

Resource/Address	List Status	No Adverse Effect	Adverse Effects			Visual
			Demolition/ Alteration of Property	Isolation/ Alteration of Surrounding Environment		
West Seattle Segment, Alternative 6.2 - New Bridge						
WS-14 Nucor Steel Mill 2424 SW Andover Street	Eligible					X
WS-81 Cherry Creek Furniture 4554 California Avenue SW	Potential SLE (City of Seattle, Historic Property Inventory, 2001)*					X
WS-82 Easy Street Records 4302 Alaska Street	Potential SLE (City of Seattle, Historic Property Inventory, 2001)*					X
WS-143 Farmers Insurance Group 5922 California Avenue SW	Eligible					X
WS-148 Residence 5933 California Avenue SW	Eligible	X				
WS-151 Residence 5948 California Avenue SW	Eligible					X
WS-154 Residence 5956-5958 California Avenue SW	Eligible					X

\* SLE: Seattle Landmark Eligible (these resources have not yet been formally evaluated by the Seattle Landmarks Board and would need to be determined as Seattle Landmarks).

<sup>a</sup> Demolition would occur with Fifth/Stewart 1 (Northwest) station.

<sup>b</sup> Visual adverse effect only would occur with Fifth/Stewart 2 (Virginia) station; demolition not required.

<sup>c</sup> Visual effect would occur with Pike 1 (West), Option B.

<sup>d</sup> Demolition would occur with Pike 1 (West), Option A.

In most cases, the alternatives examine alignment and station alternatives along the same streets, placing them near the same sets of historic resources in each segment. The majority of adverse effects to historic resources from the Green Line involve visual effects created by the placement of a modern elevated Green Line structure or station nearby. An adverse effect to the resource could vary in magnitude depending on proximity to the Green Line (for instance, by being across the street rather than directly in front of a resource) and the existing visual context. This Draft EIS analysis has assumed conservatively large stations, and the actual station development could be smaller with less visual impact. A limited number of resources could be demolished or substantially altered by the Green Line, causing an adverse effect, but in cases where this could be avoided (such as by choosing a different station alternative), the resource would still experience an adverse visual effect because the modern Green Line structure would be introduced nearby. Structural vibration effects from Green Line construction to adjacent properties constitute potential effects to historic structures. The construction vibration threshold criteria for historic buildings was set at 100 VdB for fragile buildings and 95 VdB for extremely fragile buildings (which include historic brick buildings with a high risk of cracking and the Pioneer Square Areaways. More information regarding historic resources and construction vibration effects from pile driving based on individual building descriptions, distances to the alignment, sensitivity ratings, and construction vibration activities, are described further in Section 4.17, Construction; Section 4.7, Noise and Vibration; and the Section 106, Cultural Resources Report (Appendix N).

Other criteria for evaluation of adverse effects for historic resources, including loss of access, change of function, or neglect, would not result in long-term adverse effects because the setting for the resources is



a highly urbanized area along or near high-use transportation corridors. Access to the properties would be maintained for the long term; and noise, traffic, and other changes resulting from the project (including the adverse visual effects) would not be likely to result in a change of function. Although the project's visual effects and change of setting result in an adverse effect for many of the resources in the APE, historic resources in station areas could also benefit from the long-term improvement in access, which would increase economic vitality in surrounding areas, as discussed in Section 4.4, Economics.

Potential mitigation measures for both short-term and long-term effects are discussed in Section 4.11.3, Mitigation. Specific mitigation measures for each historic resource adversely affected will be discussed in the Final EIS.

#### **4.11.3.1 Long-Term Impacts**

##### **Segment 1: Ballard Segment**

###### Alternative 1.1 - West Side of 15<sup>th</sup>

Four historical resources determined eligible for the NRHP and one historic resource (Ballard Bridge) listed in the NRHP are located along Alternative 1.1. Visual impacts from the elevated structure nearby would result in an adverse effect to a residence (B-60), apartments (B-114), Mike's Chili Parlor (B-131), and the Ballard Bridge (B-140). For the Ballard Bridge (B-140), the adverse effect also includes alteration of the surrounding environment by the introduction of a new bridge for the Green Line. Alternative 1.1 would have an adverse effect on Brekke Co. Steel Fabricators (B-132) due to the proximity of the Green Line. None of the station alternatives along this alignment would have an adverse effect on historical resources.

###### Alternative 1.2 - Center of 15<sup>th</sup>

The same four historic resources identified for Alternative 1.1 would experience adverse effects from the Green Line in the center of 15<sup>th</sup> Avenue NW. However, the adverse effects to Mike's Chili Parlor (B-131) would be higher because the placement of the elevated structure to the east of the resource would be closer and would increase the change in character to the resource's surrounding setting. This would include possible alteration of property and increased isolation because affected properties would then be located between 15<sup>th</sup> Avenue NW's approach to the Ballard Bridge and the new Green Line guideway structure. As with Alternative 1.1, none of the station alternatives would have an adverse effect on historical resources.

##### **Segment 2: Interbay Segment**

###### Alternative 2.1 - West Side of 15<sup>th</sup>/Center of Elliott

Two historic residences (I-25 and I-26) could experience adverse effects because Alternative 2.1 would pass over and potentially acquire their property. If the West Bridge approach is selected (Alternative 2.1.1), there would be adverse visual effects on a storage building at Fishermen's Terminal (I-1C), while the Far West Bridge approach (Alternative 2.1.2) would avoid the effect. Six resources would be adversely affected by the visual changes related to the elevated guideway structure nearby, including Tsubota Steel and Pipe (I-52), the Ace Tank complex (I-72, I-73, I-74), Wilson Machine Works (I-80), and Phillips Scale Co. (I-86). The Green Line would be consistent with the industrial context and utilitarian architecture of the neighborhood. There would be no effect on Leibold Communications Inc. (I-66). None of the Alternative 2.1 station alternatives would have an adverse effect on historic resources.

### Alternative 2.2 - Center of 15<sup>th</sup>/West Side of Elliott

Alternative 2.2 would create an adverse effect for one resource that is eligible for listing on the NRHP. The eastern bridge approach (Alternative 2.2) would introduce a new visual element that would change the setting for Residence and Storage, Fishermen's Terminal (I-1C). Alternative 2.2 would avoid adverse effects to the two historic residences affected by Alternative 2.1. It would have adverse visual effects to six historic properties along 15<sup>th</sup> Avenue W and Elliott Avenue W, as discussed for Alternative 2.1. There would be no effect on a residence (I-19) and Leibold Communications Inc. (I-66).

Only one station alternative within this alignment alternative would have any effects:

- **Dravus 2 (15<sup>th</sup>):** A residence (I-19) would be affected through visual effects, introduction of new construction, changes in traffic/parking/access, and noise.

### Operations Center C-1 - Interbay

No historical resources would experience adverse effects with this alternative.

## **Segment 3: Queen Anne/Seattle Center/Belltown Segment**

### Alternative 3.1 - Seattle Center/Republican

Six significant historic resources would experience adverse effects with Alternative 3.1. The guideway approach to the Queen Anne 1 (North) station could require the demolition of the Delmasse Apartments (SC-8), resulting in an adverse effect. The existing Seattle Center Monorail Terminal Office and Track (SC-16) would also be demolished, all or in part, including the track extending to Westlake Center. Options to retain a portion of the original monorail guideway through EMP would still involve an adverse effect to the resource because other portions would still be demolished. Introduction of the Green Line's elevated guideway in the immediate vicinity of historic resources would create visual effects that would have an adverse effect to 7 Queen Anne Avenue N (SC-7), Memorial Stadium (SC-22), and the Center House - Seattle Center (SC-15). This alternative would have no effect on three resources: Queen Anne Apartments (SC-13), Space Needle (SC-31), and Seattle Center Fountain (SC-32).

### Alternative 3.2 - Mercer

Four resources eligible for listing in the NRHP would be adversely affected by Alternative 3.2. As with Alternative 3.1, the guideway approach to the Queen Anne 1 (North) station could require the demolition of the Delmasse Apartments (SC-8), an adverse effect. The guideway to the station would also result in visual effects that would change the setting and cause adverse effects to 7 Queen Anne Avenue N (SC-7). The elevated structure turning from Mercer Street to Fifth Avenue N would adversely affect the Auditorium Apartments (SC-20) by creating visual effects that would alter its setting. With Alternative 3.2, there would be an option to retain the Fifth Avenue guideway of the existing Seattle Center Monorail Terminal Office and Track System (SC-16), or the Fifth Avenue guideway could be demolished; both options would involve adverse effects. The new Green Line directly beside the existing monorail would adversely affect its setting, although its function could potentially continue. The alignment would avoid Alternative 3.1's adverse visual effects to the Memorial Stadium and the Center House, and would have no adverse effect on the Queen Anne Apartments (SC-13), Space Needle (SC-31), and Seattle Center Fountain (SC-32).

### Alternative 3.3 - Thomas

The Thomas Street alignment alternative would cause adverse effects to four significant historic resources, all of which are eligible for listing in the NRHP. With a station to the southwest of Key Arena (Seattle Center/Queen Anne 2), this alternative would avoid demolition of Delmasse Apartments (SC-8),

but an adverse effect would still result due to the guideway and station's close proximity to the apartments, as well as to 7 Queen Anne Avenue N (SC-7). The guideway would visually change the setting of these historic buildings. The route through the Seattle Center would cross directly to the south of the Center House (SC-15), creating visual effects that would be considered adverse. It would also remove the existing Seattle Center Monorail (SC-16), as was described with Alternative 3.1, although the alignment itself might require removal of only that portion extending down Fifth Avenue. The Seattle Center/Fifth and Broad and Belltown station alternatives for this alignment would not result in adverse effects to historic resources.

#### Alternative 3.5 - Second/Denny

Two of the same historical resources as the resources identified under Alternative 3.2 are located in the APE of Alternative 3.5 (Second/Denny): 7 Queen Anne Avenue N (SC-7) and the Delmasse Apartments (SC-8) (Table N-3). The construction of this alternative would adversely affect the Delmasse Apartments (SC-8) and 7 Queen Anne Avenue N (SC-7) through visual effects and introduction of new construction (Table N-2), including the Seattle Center/Queen Anne 2 (South) station.

### **Segment 4: Downtown Segment**

#### Alternative 4.1 - West Side of Second

Without appropriate mitigation, Alternative 4.1 would have adverse effects on up to 81 of the historical resources identified along this alignment, with up to three resources experiencing adverse effects due to demolition, and the remainder experiencing adverse effects due to visual effects. One resource, the Pioneer Square Areaways (D-127), would experience an effect that would not be adverse (additional information on the areaways is included in Appendix N). The visual effects would be related to the introduction of the elevated structure or stations, altering views of the buildings and/or substantially changing the character of their settings. The buildings that could be demolished include the Centennial Building (D-37), Eitel Building (D-57), and Federal Reserve Bank Building (D-67); the majority of these demolitions would be related to a station site or its adjacent guideway.

All other historical resources along this alignment would be adversely affected by long-term effects through the introduction of new construction and visual effects. In the cases where the demolition of a historic resource could potentially be avoided by a different station siting option, the resource would still be adjacent to the guideway and would experience an adverse effect. Without considering design as mitigation, the Green Line columns and guideways may block views of significant architectural details such as cornices, moldings, pilasters, and window and door openings. The height of the guideways could also block views of the decorative belt coursing located above the second story of some early twentieth-century historical buildings within the Downtown Segment. Visual simulations were prepared for many buildings in the Downtown Segment and are included in the Section 106 Cultural Resources Report (Appendix N).

The historical resources affected by Alternative 4.1 include six properties individually listed in the NRHP: Seattle, Chief of the Suquamish Tribe Statue (D-2), Times Square Building (D-34), Josephinum Hotel (D-40), Doyle Building (D-49), United Shopping Tower/Olympic (D-51), and Hoge Building (D-77). Fifty historical resources are listed in the NRHP including as part of the Pike Place and Pioneer Square Historic Districts (see Table 1, Appendix N). Twenty-five other affected resources have been determined eligible for listing in the NRHP (Table 4.11-2): 2619 Fifth Avenue (D-5), 420 Vine Street (D-7), 420 Blanchard Street (D-17), Fifth Avenue Court Apartments (D-18), Sheridan Apartments (D-26), Securities Building (D-37), Mayflower Park Hotel (D-36), Centennial Building (D-33), Bon Marche (D-38), Caffè D'Arte (D-42), Haight Building (D-50), Eitel Building (D-57), Hadfield Building (D-64),

Baillargeon Building (D-66), Federal Reserve Bank Building (D-67), Exchange Building (D-68), Puget Sound Bank (D-69), Seattle Trust and Savings Bank (D-72), Hong Kong and Shanghai Banking Corporation Clock (D-73), Foster and Marshall Building (D-74), Chamber of Commerce Building (D-75), Dexter Horton Building (D-78), Lyon Building (D-89), and the Pioneer Square Areaways (D-127). The Griffin Building (D-27) is eligible to be a Seattle City Landmark.

The effects of the station alternatives for Alternative 4.1 include:

- **Fifth and Stewart 1 (Northwest):** The Centennial Building (D-37) would be demolished, and nearby historic properties, including the Securities Building (D-37), Mayflower Park Hotel (D-36), and the Bon Marche (D-38), would be adversely affected through visual effects and the change in setting related to the removal of the Centennial Building and the introduction of the new Green Line guideway and the station.
- **Fifth and Stewart 2 (Virginia):** This alternative would avoid demolition of the Centennial Building. If this station alternative were selected instead of the Fifth and Stewart 1, the Green Line guideway along Stewart Street would cause adverse visual effects to the Centennial Building, the Securities Building (D-37), the Mayflower Park Hotel (D-36), and the Bon Marche (D-38).
- **Pike 1 (West) A and B:** The Eitel Building (D-57) would be demolished with Option A. The station options differ primarily in whether the station would extend from Second Avenue to provide a connection to First Avenue; Option A would stop at mid-block while Option B would narrow the station footprint on Second Avenue to avoid demolition of the Eitel Building (the station would instead extend to First Avenue). With the removal of the Eitel Building under Option A, the station and adjacent guideways for both options would cause visual and change of setting effects to four adjacent historic properties. Option B, while not demolishing the Eitel Building, would have adverse visual effects to two additional resources located on First Avenue: Triangle Market (D-46) and Economy Market (D-59).
- **Madison 1 (West):** The Federal Reserve Bank Building (D-67) property would be acquired and demolished with this station option.
- **Yesler 1 (West):** This station option would have an adverse effect on the Smith Tower (D-95), which would be directly across Second Avenue. The station would be about the equivalent of a four-story building. Due to the demolition of an intrusive structure, there would be an offsetting positive effect on the surrounding buildings. The potential advantages to demolishing the Sinking Ship Garage would include other benefits to the neighborhood, including the creation of a more inviting public space, as well as potential new physical and visual connections to Pioneer Square Park, as discussed in Section 4.5, Visual Quality and Aesthetic Resources.

#### Alternative 4.2 - East Side of Second with Crossover

Although Alternative 4.2 involves several different station options and would be on the opposite side of Second Avenue than Alternative 4.1 from Stewart Street to south of Marion Street, the overall number of resources adversely affected is similar, at 78. With the Fifth and Stewart 3 (Lenora) station, the alternative would avoid the demolition of the Centennial Building (D-33), but would instead require demolition of the Sheridan Apartments (D-26) and Griffin Building (D-27).

Compared to Alternative 4.1, the alignment of Alternative 4.2 on the east side of Second Avenue would lessen visual effects for historic buildings on the west side (such as the Exchange Building), while increasing the effects to resources on the east side, but in all cases, the presence of the Green Line structure on Second Avenue would still remain an adverse effect to the adjacent historic resources.

Alternative 4.2 would cross over Second Avenue south of Marion Street and use the Yesler 1 station. This would avoid placing the Green Line guideway or a station immediately beside the Smith Tower (D-95), although as with Alternative 4.1, an adverse visual effect would result.

#### Alternative 4.3 - Center of Second

Except for the avoidance of demolition of historic properties for Alternative 4.1 stations, an alignment along the center of Second Avenue would adversely affect a similar number of historic resources, 78. The guideway in the center of Second Avenue could avoid placing a structure immediately in front of the historic buildings fronting Second Avenue, but it would more greatly restrict views down Second Avenue because the supporting structures for stations would extend from the sides to the middle of Second Avenue. The guideways would also be horizontally arranged, compared to the vertical arrangement that either Alternative 4.1 or 4.2 would use, which could have somewhat different impacts on street level views of upper floors of buildings and their architectural details. However, the introduction of the monorail guideway and stations on Second Avenue would remain a substantial change to the setting for these historic resources, and visual effects, including partial obstruction of views of the buildings, would still occur and would be an adverse effect.

Alternative 4.3 station alternatives include Fifth and Stewart 2 (Virginia), which has effects as described in Alternative 4.1. The effects of the other stations include view blockage because the center mezzanine stations would be relatively large and would involve a greater intrusion into the street right-of-way. There would be greater adverse effects on views than with the stations associated with either Alternative 4.1 or 4.2:

- **Pike 3 (Center):** While the Eitel Building (D-57) would not be demolished with this station option, the presence of the station and adjacent guideway would cause adverse visual effects for the Eitel Building (D-57), as well as the Doyle Building (D-49), Haight Building (D-50), and United Shopping Tower/Olympic Tower (D-51).
- **Madison 3 (Center):** The Federal Reserve Bank Building (D-67) is located one block away but would not be demolished. Adverse effects to the resource would be primarily visual due to the guideway but also due to the station structure and support across Second Avenue.
- **Yesler 2 (Center):** With a station over Second Avenue, this alternative would be more prominent than Yesler 1 (West), placing the station structure and supporting structures closer to Smith Tower. The introduction of the station and guideway on Second Avenue near Smith Tower and into the Pioneer Square Historic District would be an adverse visual effect.

#### **Segment 5: SODO Segment**

##### Alternative 5.1 - East Side of Third/Utah

Alternative 5.1 would involve visual effects, including the introduction of the Green Line structure near a historic resource determined eligible for listing in the NRHP. Markey Machinery Co. (S-58) on S Horton Street would experience adverse visual effects from the placement of the Green Line structure in front of and above it. The Rainier Cold Storage Building A (S-61) would also experience an adverse visual effect. Because the building's setting would be in the Port of Seattle industrial area, would not be immediately adjacent to the new Green Line structures, and would be surrounded by port and transportation uses, the degree of change in setting it would experience would be lower than Markey Machinery Co. No historical resources are located within the APE of the station alternatives.

### Alternative 5.2 - West Side of Third/Utah

Under this alignment alternative, three historic resources would experience adverse effects. Markey Machinery Co. (S-58) would experience adverse visual effects as described for Alternative 5.1, and a short portion of the route along First Avenue S would place the Green Line structure near the Bank of America (S-26). The effects would involve visual effects and change of setting related to the introduction of the Green Line structure near the resources. The moderate effect on Rainier Cold Storage Building A (S-61) would be as was described for Alternative 5.1. Station alternatives would not have adverse effects on historical resources.

### Operations Center C-2 - SODO

No historical resources are located in the APE of this Operations Center location.

## **Segment 6: West Seattle Segment**

### Alternative 6.1 - West Seattle Bridge

Four historic resources would experience adverse effects with Alternative 6.1. Curious Kidstuff (WS-97), a property previously identified as eligible for listing as a Seattle Landmark (City of Seattle, Historic Property Inventory, 2001), and three other properties determined eligible for listing in the NRHP, including Farmers Insurance Group (WS-143) and two residences (WS-151 and WS-154), are along California Avenue SW and would experience adverse visual effects. Nucor Steel Mill (WS-14) would experience moderate but not adverse visual effects due to the introduction of the elevated Green Line structure departing from the West Seattle Bridge and passing to the east and substantially above the property to the Delridge 1 station, which would also be highly visible. Avalon 1 (Center), Alaska Junction 1 (42<sup>nd</sup>/Edmunds), and Morgan Junction 1 (West) station options would not affect historic properties.

### Alternative 6.2 - New Bridge

Six historic resources would experience adverse effects with Alternative 6.2. All adverse effects would be visual. The affected properties include three properties along California Avenue SW: Farmers Insurance Group (WS-143) and two residences (WS-151 and WS-154). With the route along Alaska Street, Easy Street Records (WS-82) and Cherry Creek Furniture (WS-81) would experience adverse effects due to the introduction of the Green Line structure. The Alternative 6.2 alignment would cross into the Nucor Steel Mill property and the Delridge 2 (Andover) station on the property. There would be an adverse visual effect to the Nucor Steel Mill due to the construction of the station on a portion of the property, but the access to and function of the mill would not be expected to be affected. The stations at Delridge 2 (Andover), Avalon 2 (35<sup>th</sup>), Alaska Junction 2 (44<sup>th</sup>/California), and Morgan Junction 2 (Center) would not affect historic resources.

## **No Action Alternative**

Under the No Action Alternative, transportation improvements would be limited to those included in the future Seattle development projects, including transportation improvements and neighborhood redevelopment. There would be no long-term adverse effects to archaeological or historical resources from the Green Line.

#### **4.11.4 Mitigation**

Potential mitigation measures that were discussed by the City of Seattle, OAHP, and SMP are described below. Specific mitigation measures for individual historical resources will be further addressed in the Final EIS. Specific mitigation for individual resources will be developed during negotiations of the Memorandum of Understanding with the SHPO.

##### **4.11.4.1 Archaeological Resources**

Measures to mitigate adverse effects to significant unknown archaeological resources have been identified. Mitigation measures are based on estimated probabilities that buried archaeological resources may be identified during construction excavation for columns, bridge piers, stations, and the Operations Center. Mitigation measures were developed to protect archaeological resources that may be present and may be significant while minimizing construction downtime.

##### **4.11.4.2 Historical Resources**

Measures to mitigate the effects to those historical resources considered potentially significant are presented in this section. As with the effect analysis, separate mitigation measures are recommended for application during Green Line construction and during operation. These mitigation measures are presented by project segment and the different proposed alternative alignments.

SMP will coordinate with the OAHP, the City of Seattle consulting parties, and the public to identify mitigation measures that will be addressed in a formal Memorandum of Agreement (MOA) or Programmatic Agreement (PA). The MOA and/or PA will be executed before inclusion in the Final EIS, and will include a separate mitigation section within the Final EIS. The following discussion presents some of the techniques that could be incorporated into the MOA or PA (see Table 4.11-2 for a summary of effects). The potential types of mitigation for historical resources associated with project effects are described below. Specific mitigation issues associated with each segment are listed.

##### **4.11.4.3 Operation**

###### **Archaeological Resources**

No mitigation measures for long-term effects to archaeological or traditional cultural resources are required for operation of the Green Line.

###### **Historical Resources**

###### Demolition

Some of the alternatives could result in the demolition of historical resources. A description of the locations and types of resources potentially affected by demolition is listed in Table 4.11-3. There are several options to mitigate demolition. Avoiding the resource through selection of other alternatives and changes in design of a project feature in the specific area of the affected resource(s) could eliminate the need for demolition. Elements of the resource could be reflected or preserved in the design of the station or other structure whose construction would cause the demolition. If these options are not feasible, recordation (a detailed inventory for historic records) and salvage of the resource could mitigate for its loss. In cases where a resource is found to be adversely affected, recordation of the resource would be completed prior to any mitigation action, in the form of Historic American Buildings Survey/Historic

American Engineering Record (HABS/HAER) documentation, which follows National Park Service regulations.

Demolition of any historic resource within the Pioneer Square Preservation District would be reviewed pursuant to SMC 23.66, and the demolition of any designated City landmark would be reviewed pursuant to SMC 25.12. Appropriate mitigation would be pursued as required in those provisions.

Non-site-specific mitigation could involve finding other opportunities in the community for mitigation measures that are not specific to the affected site. Some of the options for non-site-specific mitigation include the development of educational interpretive displays; creating design guidelines that focus on compatible materials, massing, and scale with historical resources for the introduction of new construction (such as station design); historical Multiple Property NRHP Nominations for certain neighborhoods; and professional publications. These mitigation measures would not be direct mitigation for the effect of the Green Line but would relate to other resources in the area.

#### Traffic Congestion/Access/Isolation

Loss of access or isolation of resources could be minimized through design treatments. Creation of alternative access points, more visible temporary signage, or additional traffic control could facilitate accessibility. There may be a need for a formal Access Mitigation Plan during construction as part of the undertaking (refer to Section 4.1, Transportation).

#### Noise and Vibration

Increased vibration after the construction of the Green Line could be minimized through vibration suppression, including the setting back of support columns from buildings and effective maintenance to control ground-borne vibration, and design treatments. There should be no adverse effects to historical resources from the long-term function of the Green Line (see Section 4.7, Noise and Vibration).

#### Visual

There would be effects associated with changes in visual character due to operation of the Green Line. Some visual effects could be mitigated through the placement of guideway columns to avoid major entrances to historic buildings. Station design, construction, materials, and street improvements could be chosen to compliment existing building and street settings. Use of low-effect colors and low-glare glass could reduce some of the effects on stations within the Pioneer Square Historic District or areas with a high number of historical resources, such as the Downtown Segment.

In areas where the concentration of historical resources is very high, such as the Downtown Segment and the Pioneer Square Historic District, locations of columns could be planned to avoid placement in front of historical resources, especially building entries. Due to the number of visual effects to historical resources identified within the undertaking where there are no direct mitigation measures, off-site mitigation measures could be proposed, such as the development of a Multiple Property National Register Nomination for specific types of historical resources (see Appendix N, Section 106 Cultural Resources Report, and Section 4.5, Visual Quality and Aesthetic Resources).

The design for Green Line stations and associated street improvements adjacent to historical resources would be subject to design review to ensure compatibility with historical resources.



### Change of Use

No significant adverse effects to historic uses in historic districts have been identified at this time.

#### **Segment 1: Ballard Segment**

The types of mitigation measures for all of the alternatives within this segment are the same because the types of effects are the same (visual, isolation/alteration of surrounding environment), with the exception of Mike's Chili Parlor (B-131). Under the proposed Alternative 1.2, there could be demolition or alteration of this historical resource due to the potential location of the guideway directly above the building.

The potential mitigation measures listed above could be undertaken for historical resources within this segment. Creative design solutions could be applied to the design, construction, and materials of a new Green Line bridge as currently proposed that parallels the existing Ballard Bridge (B-140).

#### **Segment 2: Interbay Segment**

The types of mitigation measures for all the alternatives within this segment are the same for historical resources because the types of effects are the same (visual, isolation/alteration of surrounding environment). The potential mitigation measures listed above could be undertaken for historical resources within this segment.

#### **Segment 3: Queen Anne/Seattle Center/Belltown Segment**

The type of mitigation measures for all the alternatives within this segment are the same for historical resources because the types of effects are the same (visual, demolition, or alteration of property). In cases where a resource is found to be adversely affected due to demolition, such as The Delmasse Apartments (SC-8), recordation of the resources (HABS/HAER) would be completed before any mitigation action.

Non-site-specific mitigation could be undertaken for the numerous historical resources within the Queen Anne/Seattle Center/Belltown Segment that could be visually affected by the introduction of new, non-compatible construction of the Green Line guideway and stations. A Multiple Property NRHP Nomination of Apartment Buildings within the Lower Queen Anne and Downtown neighborhoods could be required in the MOA.

#### **Segment 4: Downtown Segment**

The height of the guideways could block views of the decorative belt coursing located above the second story of some early twentieth century historical buildings within the Downtown segment. Visual simulations were prepared for many buildings in the Downtown Segment and are included in the Section 106 Cultural Resources Report (Appendix N).

Recordation of the resources (HABS/HAER) would be completed before any mitigation action, in cases of adverse effects due to demolition. Resources that may be demolished include the Sheridan Apartments (D-26), Centennial Building (D-37), Eitel building (D-57), and the Federal Reserve Bank Building (D-67). Creative design solutions that avoid demolition and/or minimize effects to historic structures could also become mitigation for adverse visual effects.

Non-site-specific mitigation would be undertaken for the numerous historical resources within the Downtown Segment that would be visually affected by the introduction of new, non-compatible

construction of the Green Line guideway and stations. A Multiple Property National Register Nomination of Apartment Buildings within the Downtown neighborhoods could be included in the MOA.

#### **Segment 5: SODO Segment**

The type of mitigation measures for all the alternatives within this segment are the same for historical resources because the types of effects are the same (visual, isolation/alteration of surrounding environment). The potential mitigation measures listed above could be undertaken for historical resources within this segment.

#### **Segment 6: West Seattle Segment**

The type of mitigation measures for all the alternatives within this segment are the same for historical resources because the types of effects are the same (visual, demolition/alteration of property). Recordation of the resources (HABS/HAER) would be completed before any mitigation action in cases where a resource is adversely affected due to demolition or alteration of the property.

Non-site-specific mitigation could be undertaken for the numerous historical resources within the West Seattle Segment that could be visually affected by the introduction of new, non-compatible construction of the Green Line guideway and stations. A Multiple Property NRHP Nomination of Craftsman Style Buildings within the West Seattle neighborhood could be required in the MOA.

### **4.11.5 Significant Unavoidable Adverse Impacts**

#### **4.11.5.1 Archaeological Resources**

No significant unavoidable adverse effects to archaeological resources or traditional cultural resources would occur. All effects could be mitigated through development of a Programmatic Agreement, an Archaeological Treatment Plan, and an Archaeological Construction Monitoring Plan for the Green Line project.

#### **4.11.5.2 Historical Resources**

New construction of the proposed Green Line could have a significant unavoidable adverse effect by altering the character of the setting of significant historical resources and the visual character of the Pioneer Square Historic District. Visual effects to the district and individual historic resources within the district would adversely affect their visual integrity. Some of these effects could be mitigated through creative design solutions, such as compatible station design and the placement of columns away from historic buildings. Other adverse effects could be mitigated through off-site mitigation measures (described in the mitigation section) that could compensate for effects. The demolition of historic buildings, however, would be a significant unavoidable adverse effect, unless it can be avoided through redesign.